A SYSTEM OF ANATOMY

FOR THE USE OF

STUDENTS OF MEDICINE.

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CONTENTS OF VOL. II.

PART VII.

OF THE ABDOMEN.

CHAPTER I.

GENERAL VIEW OF THE ABDOMEN AND PELVIS, AND THEIR CONTENTS. GENERAL ANATOMY OF THE SEROUS TISSUES. OF THE PERITONEUM.

CHAPTER II.

GENERAL STRUCTURE OF THE ALIMENTARY CANAL. OF THE ŒSOPHAGUS, STOMACH, INTESTINES, ETC.

CHAPTER III.

OF THE LIVER, PANCREAS, AND SPLEEN.

CHAPTER IV.

OF THE URINARY ORGANS AND GLANDULÆ RENALES.

CHAPTER V.

OF THE MALE ORGANS OF GENERATION.

CHAPTER VI.

OF THE FEMALE ORGANS OF GENERATION.

PART VIII.

GENERAL ANATOMY OF THE SANGUIFEROUS SYSTEM.

CHAPTER VII.

BLOOD-VESSELS IN GENERAL. GENERAL ANATOMY OF THE ARTERIAL SYSTEM. OF THE HEART. OF THE VENOUS SYSTEM.

CHAPTER VIII.

DISTRIBUTION OF THE ARTERIES.

CHAPTER IX.

OF THE PARTICULAR DISTRIBUTION OF THE VEINS.

PART IX.

GENERAL ANATOMY OF THE ABSORBENT SYSTEM.

CHAPTER X.

ABSORBENTS OF THE LOWER EXTREMITIES, ABDOMEN AND THORAX.

CHAPTER XI.

ABSORBENTS OF THE HEAD AND NECK, UPPER EXTREMITIES, AND UPPER PART OF THE TRUNK OF THE BODY.

PART X.

OF THE BRAIN AND SPINAL MARROW—OF THE EYE AND THE EAR.

CHAPTER XII.

OF THE BRAIN,

CHAPTER XIII.

OF THE SPINAL MARROW.

CHAPTER XIV.

OF THE EYE.

CHAPTER XV.

OF THE EAR.

PART XI.

OF THE NERVES.

CHAPTER XVI.

GENERAL ANATOMY OF THE NERVOUS SYSTEM.

CHAPTER XVII.

OF THE SPECIAL ANATOMY OF THE SPINAL MARROW AND BRAIN, AS DESCRIBED FROM BELOW UPWARDS.

SYSTEM OF ANATOMY.

PART VII.

OF THE ABDOMEN.

The lowermost of the two great cavities of the trunk of the body is called *Abdomen.* The pelvis may be considered as a chamber of this cavity, although its structure is very different.

CHAPTER I.

A GENERAL VIEW OF THE ABDOMEN AND PELVIS AND THEIR CONTENTS. GENERAL ANATOMY OF THE SEROUS MEMBRANES. OF THE PERITONEUM.

Of the Abdomen.

This great cavity occupies more than half of the space enclosed by the ribs, and all the interior of the trunk of the body below the thorax.

It is formed by the diaphragm, which is supported by the lower ribs; by a portion of the spine; by the various muscles which occur between the lower margin of the thorax and the upper margin of the ossa innominata, which contribute, for the same purpose, the costæ of the ossa ilia, as well as the pelvis.

The general figure of this cavity partakes of the figure of the lower part of the trunk of the body; with these exceptions, that

the diaphragm makes it arched or vaulted above, that the spine and psoæ muscles, &c. are rather prominent on the posterior surface, and that the lower part corresponds with the costæ of the ossa ilia and with the pelvis.

To acquire a precise idea of this cavity, it is necessary first to study the bones concerned in its structure, in their natural situation in the skeleton; and then the muscles, which form so large a part of it.

The arrangement of the tendons of some of these muscles, with a view to complete the cavity, is particularly interesting; as that of the external oblique where it forms the crural arch.* The ligaments of the pelvis and the levatores ani muscles, as they also contribute to the formation of the cavity, and have an influence upon its figure, should likewise be attended to.

In the walls of the cavity, thus constructed, there are many foramina, by which the viscera and other contained parts communicate externally; but few of them pass directly into the cavity; for, like the thorax, there are no vacuities in it, exterior to the contained organs.

Three of these foramina are in the diaphragm. One for the transmission of the aorta, another for the vena cava, and a third for the œsophagus. Below, there is an aperture at each of the crural arches, for the transmission of the great femoral vessels; in each of the ligamentous membranes which close the foramen thyroideum, for the obturator vessels and nerve; and at the sacro-sciatic notches, for nerves and blood-vessels.

There are also two apertures at the bottom of the pelvis, for the orifice of the rectum and of the urethra. In the tendons of the external oblique muscles are two orifices, covered by the integuments, for the spermatic cords; and, in the fœtal state, one for the umbilical cord.

The apertures in the tendons, and under their edges, for the transmission of the spermatic cords, and the blood-vessels, &c. are not to be considered as simple perforations made abruptly;

* See the account of this tendon, vol. i. in the description of the "Obliquus Descendens Externus."

but the edges of these foramina are formed by tendinous membranes turned inwards, and continued so as to compose a cylindrical tube, which becomes gradually so thin that it cannot be readily distinguished from the cellular membrane with which it is connected.* The blood-vessels, &c. pass along this tube before they go through the apertures.

It is evident from the construction of this cavity, that it is essentially different from the thorax. It has no power of spontaneous dilation whatever: it yields passively to the distention of the stomach and intestines, during deglutition, and when air is extricated from the aliment &c.; but it is particularly calculated for compressing its contents by the contraction of the muscles which compose it. The diminution of its capacity, which is thus effected, not only takes place to a great degree, but occasionally with great force. The diaphragm and the abdominal muscles may be considered in some measure as antagonists of each other. When the diaphragm descends, if the abdominal muscles are passive, they are distended by the contents of the abdomen, which are forcibly pressed from above: but if the abdominal muscles act at the same time, an effort to diminish the cavity in every direction takes place, and the contained parts are compressed with more or less force according to the exertion made. This will be very evident upon examining the situation of the diaphragm and of the abdominal muscles. When their force is considered, it will also be very obvious that the various outlets of the cavity are constructed most advantageously; otherwise hernia or protrusion of its contents would be a daily occurrence.

The abdomen contains, 1st, *The Stomach and the whole Intestinal Tube*, consisting of the small and the great intestines.

2d. *The Assisting Chylopoietic Viscera*,—the Liver, the Pancreas, and the Spleen.

3d. *The Urinary Organs*,—the Kidneys, the Ureters, and the Bladder. To which should be added the Glandulæ Renales.

4th. *The Organs of Generation* in part: those of the female

* The student of anatomy, when engaged with this subject, will be gratified by the examination of Mr. Astley Cooper's plates relating to herniæ.

sex being almost wholly included in the pelvis; and those of the male being situated partly within and partly without it.

5th. *The Peritoneum* and its various processes. The Mesentery, Omentum, &c.

6th. *A portion of the Aorta, and almost the whole of the Inferior Cava*, and their great ramifications: with such of their branches as are appropriated to the Viscera of the Abdomen and Pelvis.

7th. *Those portions of the Par Vagum and Intercostal Nerves* which are appropriated to the cavity; and portions of some of the nerves destined to the lower extremities.

8th. *The lower part of the Thoracic Duct*, or the Great Trunk of the Absorbent System, with the large branches that compose it, and the glands connected with them: and also those absorbent vessels called *Lacteals*, and their glands.

As the cavity of the abdomen has no natural divisions, anatomists have divided it by imaginary lines into various regions, with a view to precision in their accounts of the situation of the different contained parts. Thus,

They have, very generally, agreed to apply two transverse lines to form three great divisions; viz. the *Upper*, *Middle* and *Lower:* and they have also agreed that each of these divisions shall be subdivided into three regions.

The three regions of the uppermost division are defined with some precision. Those on each side, which are called the *Right* and *Left Hypochondriac regions*, occupy the space immediately within the lower ribs and their cartilages; while the middle space, included within the margins of these cartilages and a line drawn from the lower edge of the thorax on one side to that on the other, is denominated the *Epigastric region*.

The boundaries of the regions below are less precisely defined.

Many anatomists have fixed the two transverse lines above mentioned, at an arbitrary distance above and below the umbilicus: some choosing for this purpose two inches, and others a hand's breadth. As these distances will occupy different proportions of the cavity in persons of different stature, other anatomists, with a view to avoid this inconvenience, have proposed to connect these lines with certain fixed points of the skeleton.

It is of importance that the boundaries of these regions should be fixed, and therefore the proposition of Sabatier may be adopted; namely, To draw the upper transverse line from the most inferior part of the lower margin of the thorax, on one side, to the corresponding part on the opposite side; and the lower transverse line from the uppermost part of the spine of one ilium to the same part of the other. These lines will mark the three great divisions. If, then, two parallel lines are drawn directly upwards, one from each of the superior anterior spinous processes of the ilium,* until it touches the lower margin of the thorax, they will divide each of the two lower divisions of the abdomen into three regions. The centre of the middle division is the umbilical, and on each side of it is the right and left lumbar region. The middle of the lower division is the hypogastric; and on each side of it the right and left iliac region.

It is true that the three middle regions of the abdomen will be made very small by the vicinity of the transverse lines to each other; but the advantages derived from a principle which is similar in its application to all subjects, fully compensates for this inconvenience.

There are therefore nine of these regions; namely, The Epigastric and the two Hypochondriac: the Umbilical, and the two Lumbar: the Hypogastric, and the two Iliac regions.† And it should be added, that the space immediately around the end of the sternum is sometimes called the *Scrobiculus Cordis;* and the space immediately within the os pubis, the *Regio Pubis.*

These different regions are generally occupied in the following manner: The liver fills nearly the whole of the right hypochondriac region, and extends through the upper part of the epigastric region into the left hypochondriac. The stomach occupies the principal part of the epigastric region, and a considerable portion of the left hypochondriac. The spleen is also situ-

* Professor Horner makes a more equable division of the cavity of the abdomen, by drawing the two vertical lines from the anterior *inferior* spinous process of the ilium, so as to divide each of the three divisions made by the transverse lines, into three nearly equal parts.—P.

† It is to be observed that the lateral regions of the middle and lower divisions of the abdomen are named differently by different writers.

2 *

ated in the left hypochondriac region. That portion of the intestinal tube, which is composed of small intestines, is generally found in the umbilical, the hypogastric, and the iliac regions, and when the bladder is empty, in the pelvis. But the duodenum, or first of the small intestines, which proceeds immediately from the stomach, is situated in the epigastric and umbilical regions. The great intestine commences in or near the right iliac region, and ascends through the right lumbar to the right hypochondriac region. It then crosses the abdomen, passing through the lower part of the epigastric, or upper part of the umbilical to the left lumbar region: from this it continues into the left iliac region, and curves in such a manner that it finally arrives at the middle of the upper part of the os sacrum, when it descends into the pelvis, and, partaking of the curvature of the last mentioned bone, continues to the termination of the os coccygis.

In the back part of the epigastric region, and very low down in it, is situated the pancreas. The kidneys lie in the most posterior parts of the lumbar regions, and from each of them is continued a tube or duct, called *Ureter*, that passes into the pelvis to convey the urine into the bladder. This viscus, in males, is in contact with the last portion of the great intestine called the *Rectum*, and with it occupies almost all the cavity of the pelvis; while in females, the uterus and its appendages are situated between this intestine and the bladder.

In the posterior part of the abdomen, in contact with the spine, is the aorta. This great blood-vessel passes from the thorax between the crura of the diaphragm, and continues down the spine until it approaches towards the pelvis, when it divides into two great branches called the *Iliac Arteries.* Each of these great branches divides again, on the side of the pelvis, into two; namely, the *External Iliac*, which passes under the crural arch to the thigh, and the *Internal Iliac*, or *Hypogastric*, which descends into the cavity of the pelvis.

Soon after the arrival of the aorta in the abdomen it gives off two large branches. The first, which is called the *Cœliac*, is distributed to the liver, the stomach, and the spleen: the second,

called the *Superior Mesenteric*, is spent upon the intestines. Lower down in the abdomen, it also sends off a small branch for the intestines, called *Inferior Mesenteric*. Besides these vessels for the chylopoietic viscera, the aorta sends off a large branch, called *Emulgent*, to each kidney.

The inferior or ascending vena cava is situated on the right of the aorta, in front of the spine. It is formed below by the union of the iliac veins, and in its progress upwards, it receives the emulgent veins, which correspond to the arteries of the kidneys; but it receives in its course no veins which correspond directly with the cœliac and mesenteric arteries. The smaller veins that answer to the branches of these arteries, unite and form one large vein, which goes to the liver, and is called (from the part of that viscus at which it enters,) *Vena Portarum*. From the liver three large veins pass into the vena cava, and deposit there the blood of the vena portarum, after it has furnished materials for the secretion of bile. The vena cava, in its passage upwards, is in close contact with the posterior thick edge of the liver: it often passes along a deep groove in this edge, and sometimes it is completely surrounded by the liver in its course. The veins of the liver enter the vena cava at this place, and of course they are not to be seen without dissection. Immediately after leaving the liver, the vena cava passes through an aperture in the tendinous centre of the diaphragm to unite itself to the right auricle of the heart.

EXPLANATION OF PLATE VIII.

Fig. 1. Shows the Contents of the Thorax and Abdomen in situ.

1. Top of the Trachea, or windpipe. 2, 2, The internal jugular veins. 3, 3, The subclavian veins. 4, The vena cava descendens. 5, The right auricle of the heart. 6, The right ventricle. 7, Part of the left ventricle. 8, The aorta descendens. 9. The pulmonary artery. 10, The right lung, part of which is cut off to show the great blood-vessels. 11, The left lung entire. 12, 12, The anterior edge of the diaphragm. 13, 13, The two great lobes of the liver. 14, The ligamentum rotundum. 15, The gall-bladder. 16, The stomach. 17, 17, The jejunum and ilium. 18, The spleen.

Fig. 2. Shows the Organs subservient to the Chylopoietic Viscera,—with those of Urine and Generation.

1, 1. The under side of the two great lobes of the liver. a, Lobulus spigelii. 2, The ligamentum rotundum. 3. The gall-bladder. 4, The pancreas. 5, The spleen. 6, 6, The kidneys. 7, The aorta descendens. 8, Vena cava ascendens. 9, 9, The renal veins covering the arteries. 10, A probe under the spermatic vessels and a bit of the inferior mesenteric artery, and over the ureters. 11, 11, The ureters. 12, 12, The iliac arteries and veins. 13, The intestinum rectum. 14, The urinary bladder.

Fig. 3. Shows the Chylopoietic Viscera, and Organs subservient to them, taken out of the body entire.

A A, The under side of the two great lobes of the liver. B. Ligamentum rotundum. C, The gall-blader. D, Ductus cysticus. E, Ductus hepaticus. F, Ductus communis choledochus. G, Vena portarum. H, Arteria hepatica. I, The stomach. K K, Venæ and arteriæ gastro-epiploicæ, dextræ and sinistræ. L L, Venæ and arteriæ coronariæ ventriculi. M, The spleen. N N, Mesocolon, with its vessels. O O O, Intestinum colon. P, One of the ligaments of the colon, which is a bundle of longitudinal muscular fibres. Q Q Q Q, Jejunum and ilium. R R, Sigmoid flexure of the colon with the ligament continued, and over, S, The intestinum rectum. T T, Levatores ani. U, Sphincter ani. V, The place to which the prostate gland is connected. W, The anus.

Fig. 4. Shows the Heart of a Fœtus at the full time, with the Right Auricle cut open, to show the Foramen Ovale, or passage between both Auricles.

a, The right ventricle. b, The left ventricle. c c, The outer side of the right auricle stretched out. d d, The posterior side, which forms the

ANATOMY

Plate VIII

Sect. Philad.

anterior side of the septum. e, The foramen ovale, with the membrane or valve which covers the left side. f, Vena cava inferior passing through. g, A portion of the diaphragm.

Fig. 5. Shows the Heart and Large Vessels of a Fœtus at the full time.

a, The left Ventricle. b, The right ventricle. c, A part of the right auricle. d, Left auricle. e e, The right branch of the pulmonary artery. f, Arteria pulmonalis. g g, The left branch of the pulmonary artery, with a number of its largest branches dissected from the lungs. h, The canalis arteriosus. i, The arch of the aorta. k k, The aorta descendens. l, The left subclavian artery. m, The left carotid artery. n, The right carotid artery. o, The right subclavian artery. p, The origin of the right carotid and right subclavian arteries in one common trunk. q, the vena cava superior or descendens. r, The right common subclavian vein. s, The left ocmmon subclavian vein.

N. B. All the parts described in this figure are to be found in the adult, except the canalis arteriosus.

General Anatomy of Serous Tissues.

—The serous tissue, is found in every part of the body where there is an habitual movement of parts upon each other. Its object appears to be to diminish friction and to facilitate motion, by the glassy smoothness of the free surfaces which it presents, and by its pouring out continually a lubrifying liquid between the surfaces where motion occurs. The serous system consists of a great number of membranes, forming closed sacs,* which are adherent by their external surface to the organs which they line;—their internal surface is free and smooth, and secretes a fluid, with which they are constantly, in a healthy state, moistened, analogous to the serum of the blood. The adhesion of the outer surface of the serous tissues to the subjacent parts, is so intimate in most places, that it has only been within latter times, by the labours of Bonn, Monro, and Bichat, that their proper character has been determined. They consist of the peritoneum, the pleura, the pericardial lining membrane, the arachnoid of the brain and spinal marrow, the tunica vaginalis testis, and the synovial capsules† of the joints and tendons. The serous membranes are all extremely thin, delicate and of a transparent whiteness; they are attached to the parts they cover by the intermedium of cellular tissue, which in some parts is long and loose, and in others so short and dense as to be scarcely discernible and to which they seem to form a simple serous facing. Hence Bordeu, and Rudolphi were disposed to consider it as a modification of cellular tissue, formed by the flattening of the cells of the latter.

—Though this is true probably in regard to their ultimate structure, yet since they exist, as Bichat has shown us, as distinct membranes in the early periods of fœtal life, and as their diseases exhibit peculiar phenomena, they deserve to rank among the elementary tissues of the body. Some of the serous membranes consist merely of a simple bag of greater or less size—some line

* The peritoneum of the female, which has the fallopian tube opening into its cavity, is the only instance of a serous membrane which is not a closed sac.—P.

† The synovial membranes were considered by Bichat as forming a distinct tissue, which he named synovial.—P.

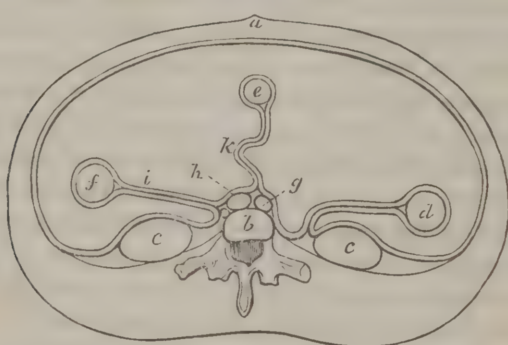
cavities which are very irregular in surface and shape—and others, like the pleura and peritoneum, are reflected over the inner face of the viscera, like the internal fold of the double night-cap over the head, and presenting a very complicated arrangement, so that the viscera which the membrane lines are necessarily left upon its outer side. All the vessels which enter these viscera, pass between the two layers that form the roots of the folds by which they are embraced. (See Fig. 43, p. 26.) —In the healthy state the serous membranes are perfectly white and insensible; and when in a state of inflammation, the apparent redness of the membrane is frequently owing to the injection of the sub-serous cellular tissue. Nevertheless they contain a vast number of serous capillary vessels, which Ruysch succeeded in injecting in such abundance, as to be led to think they were composed chiefly of these vessels. Mascagni was equally successful in filling their lymphatics, and considered *these* vessels the principal elements in the composition of serous tissues. Both, therefore, exist in great numbers, and woven together with some intermediate connecting fibres like those of the cellular tissue, constitute these membranes. This, too, is the ultimate composition of cellular tissue as proved by the recent researches of Müller and Treviranus. (See vol. i. p. 371.) The serous membranes are said to yield gelatine by boiling, and in this respect also they agree with the cellular membrane. The serous capillaries pour out a lubricating serous fluid, (called *halitus* from its vapoury condition during life, and which condenses as the body cools after death,) by a process called exhalation, which we do not fully understand, and which the absorbents gradually remove during health, so as to prevent its accumulation. But when the usual healthy balance of action between them is disturbed, by too copious exhalation, or languid absorption, dropsy may take place in any one of what are called the serous cavities of the body. There is not in fact, though the term is in general use, any *cavity* or unoccupied space in the interior of any of these membranes. In the healthy state, organ is in contact with organ, and the reflected membranes with which they are lined, slide over those which line the parietes of the so called cavities.

And when the area of a joint is suddenly enlarged, as those of the fingers may be by pulling at the phalanges, the fluid within becomes rarified to fill the vacuum, and is the cause of the snapping noise heard when the bones return in contact. The same phenomenon is sometimes observed in mastication, produced by the relaxation of the ligaments of the temporo-maxillary articulation. —Though no nerves have been traced satisfactorily to the serous membranes, and they appear to possess little or no sensation in a physiological state, they become exquisitely sensitive when suddenly inflamed, as in pleuritis.—

Of the Peritoneum.

The abdomen, thus constructed and occupied, is lined by a thin firm membrane called *Peritoneum*, which is extremely smooth on its internal surface, and is immediately connected with the cellular substance exterior to it. This membrane adheres closely to the anterior, lateral and superior portions of the surface of the abdomen; and is extended from the posterior surface so as to cover, more or less completely, the viscera of the cavity.

Fig. 42.*



Those viscera which are in close contact with the posterior surface of the abdomen, as some portions of the large in-

* Diagram representing the transverse section of the abdomen, in the lumbar region. *a*, Umbilicus. *b*, A lumbar vertebra. *c*, Kidneys. *d*, Ascending colon. *e*, Small intestine. *f*, descending colon. *g*, Inferior vena cava. *h*, Aorta. *i*, Left mesocolon. *k*, Mesentery. *l*, Right mesocolon.

testine, are covered only on their anterior surfaces, and are fixed in their precise situation by the peritoneum; which extends from them to the contiguous surface of the cavity, and adheres where it is in contact, so as to produce this effect.

Other viscera, which are not in close contact, but movable to a distance from the posterior surface of the abdomen, are covered by this membrane, which is extended to them from the surface; and this extended portion forms an important part of the connexion between the viscus and the cavity in which it lies. This connecting part is called *Mesentery*, when it thus passes to the small intestines; *Mesocolon*, when it goes to the colon, one of the larger intestines; and *Ligament*, when it passes to some of the other viscera.

The peritoneum is a complete but empty sac, which is fixed in the abdomen anterior to the viscera. The anterior portion of this sac forms the lining to the anterior and lateral parts of the surface of the abdomen: the posterior portion covers the viscera, and forms the mesentery, mesocolon, and ligaments above described.

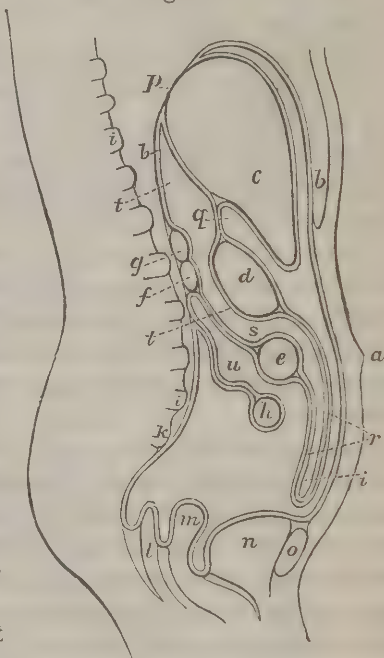
It necessarily follows that the mesentery and the other similar processes are mere plaits or folds of the sac, which invests the viscera; and that they must consist of two lamina; and as the blood-vessels, nerves, and absorbents, are all posterior to the peritoneum, they naturally pass between these lamina of the mesentery.

Some of the viscera are much more completely invested with the peritoneum than others. The stomach, liver, and spleen are almost completely surrounded by it; and it is said to form a coat for each of these viscera. That portion of the smaller intestinal tube, which is called *jejunum* and *ileum*, and the transverse portion of the large intestine, called the *arch of the colon*, are invested by it in the same way. But a considerable portion of the duodenum and the pancreas is behind it. The lateral portions of the colon are in close contact with the posterior surface of the abdomen, and the peritoneum only covers that portion of their surfaces which looks anteriorly towards the cavity of the abdomen, and is not in contact with its posterior surface.

The urinary organs are not much connected with the peritoneum. The kidneys appear exterior to it, and behind it: the bladder of urine is below it, and has but a partial covering from it, on its upper portion.

The peritoneum, which covers the stomach, is extended from the great curvature of that organ so as to form a large membrane, which descends like an apron before the intestines. This process of peritoneum is composed of two lamina, so thin and delicate as to resemble cellular membrane, which, after extending downwards to the lower part of the abdomen, are turned backwards and upwards, and proceed in that direction until they arrive at the colon, which they enclose, and then continue to the back of the abdomen, forming the mesocolon. The part of this process which is between the stomach and the colon, is called *Epiploon* or *Omentum*.

Fig. 43.*



This extension of a membrane, from the surface of a cavity which it lines, to the external surface of a viscus in that cavity, is called by some anatomists, "reflection;" and the technical term *reflected membrane* is therefore applied to a membrane distributed like the peritoneum.

It must be evident that this distribution of the peri-

* Fig. 43 is a diagram, illustrating the reflections of the peritoneum. *a*, Umbilicus. *b*, *b*, Diaphragm. *c*, Liver. *d*, Stomach. *e*, Transverse colon. *f*, Duodenum. *g*, Pancreas. *h*, Small intestine. *i*, Vertebral column. *k*, Promontory of the sacrum. *l*, Rectum. *m*, Uterus. *n*, Bladder. *o*, Symphysis pubis. *p*,

toneum is very complex, and that it is not easy to form an accurate conception of it from description, but it can be readily understood by demonstration; therefore no farther account of its arrangement will now be attempted, but each of its processes will be considered with the organs to which they are particularly subservient.

That portion of the peritoneum which lines the abdomen, and covers the viscera, is thin and delicate, but very firm. It yields to distention, as in pregnancy, ascites, &c., and again recovers its dimensions. It was formerly thought to be composed of two lamina, but this cannot be proved. The internal surface of this membrane is very smooth, and highly polished; and from it exudes a liquor which is well calculated for lubrication, and barely sufficient to keep the surface moist during health; but sometimes it is very abundant, and occasions the aforesaid disease—ascites. This fluid appears to exude from the surface of the peritoneum when it is compressed in a living animal, or one recently dead. It is probably effused from the extremities of arteries, for an effusion takes place when water is injected into these vessels.

The peritoneum abounds with absorbent vessels, and therefore possesses the power of absorption to a great degree. This power may be inferred, not only from the spontaneous removal of the fluid of ascites, but if milk and water be introduced into the abdomen of a living animal, through a puncture, it will also disappear.

The blood-vessels of the peritoneum are derived from those which supply the neighbouring parts. Nerves have not yet been traced into it, and it has little or no sensibility.

This membrane supports the viscera of the abdomen in their proper situations; and also forms a surface for them, and for the cavities which contain them, so smooth and lubricated, that no injury can arise from their friction.

The cellular substance, by which the peritoneum is connected

Coronary ligament of the liver. *q*, Omentum minus or hepatico-gastricum. *r*, Omentum majus, or gastro-colicum. *s*, Transverse mesocolon. *t*, Sac of the omentum majus. *u*, Mesentery.—P.

to the contiguous parts, is very different in different places. It is very short indeed between this membrane and the stomach and intestines, and also between it and the tendinous centre of the diaphragm. Between the peritoneum and the muscles generally, it is much longer. When it covers the kidneys and the psoas muscle, it is very lax and yielding. About the kidneys a large quantity of adeps very commonly collects in it. On the psoas muscle it yields with but little resistance to the passage of pus, or any other effused fluid, as in the case of the psoas abscess.

CHAPTER II.

OF THE GENERAL STRUCTURE OF THE ALIMENTARY CANAL. OF THE ŒSOPHAGUS, THE STOMACH, AND THE INTESTINES.

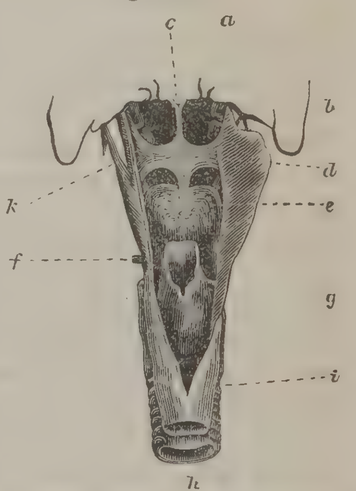
General Structure of the Alimentary Canal.

—This canal, formed of the œsophagus, stomach, and intestines, extends inclusively from the pharynx to the anus. It is composed throughout, (with the exception of the œsophagus, the transverse part of the duodenum, and the termination of the rectum, which want the serous coat,) of four membranes or tunics; an *internal mucous* coat, one exterior to this, *fibro-cellular* or *nervous,* a third more external still, which is *muscular;* and of a fourth investing serous coat, which is derived from the peritoneum lining the cavity of the abdomen. There enter also into its composition, mucous glands, nerves, blood-vessels, and absorbents. The arrangement of the serous tunic varies in different portions of the canal; but its general arrangement is such, that it embraces the canal, and serves as a ligament to connect it to the back and lateral parts of the abdominal parietes, so as effectually to prevent any entanglement or knotting in the folds of the canal, and at the same time allow it great latitude of motion. It is united to the outer face of the muscular coat, by cellular tissue. The muscular tunic is of a pale colour, soft, and easily lacerated.

—The muscular tunic consists throughout of two orders of fibres, a *circular* which is *internal,* and a *longitudinal* which is *external.* The former are not *entirely* circular, but consist of segments, which, by their reunion, constitute perfect circles. The latter do not run the whole length of the tube, but are interrupted after short courses. Both may be considered as having their origin and insertion in the fibro-cellular tunic, which separate them from the

mucous membrane. The fibro-cellular (*cellular* or *nervous* coat,) forms a perfect cylinder, and is composed of fibres of condensed cellular tissue intercrossed in different directions. It is the strongest of all the tunics, and gives to the canal its greatest power of resisting internal distention. The nerves ramify abundantly in this tunic before they reach the mucous, and hence the organic suffering and often sudden death, resulting from sudden tympanitic distention of the alimentary canal. The mucous membrane of the canal is every where continuous. It is of a reddish colour, soft and fungous in its consistence, and varies in its thickness, and in the number of the villi, follicles, and folds, which it forms in different portions of the canal.—

*Fig. 44.**



Of the Œsophagus.

The Œsophagus is a muscular tube which passes from the pharynx to the stomach, and is so intimately connected with the stomach, that it will be advantageous to the student to attend to its structure immediately before he engages in the examination of that important organ.

* Fig. 44. The pharynx slit open behind, in order to show the relative position of the opening of the posterior nares, the velum pendulum palati, the floor of the mouth, and the opening of the larynx. *a*, Base of the cranium. *b*, Mastoid process of the temporal bone. *c*, Vertical partition between the nasal fossæ, of which is seen the termination behind. *d*, Velum pendulum palati, a fleshy appendage to the osseous palate; at its middle part, projecting downwards and backwards is seen the *uvula*, and on each side of the uvula, are seen the buccal cavities. *e*, Base of the tongue. *f*, Extremity of the os hyoides; on the opposite side, this bone is entirely concealed, by the portion of the posterior wall of the pharynx, which is folded outwards. *g*, Glottis, or opening of the larynx; the epiglottis is seen above and in front of this opening, and is in this figure applied against the base of the tongue. *h*, Part of the trachea. *i*, Commencement of the œsophagus. *k*, Levator pharyngeus muscle.—P.

—The commencement of the cavity of the pharynx, from the base of the cranium, and its position behind the posterior opening of the cavities of the nose, mouth, and glottis, are well seen in Fig. 44, page 30. Its termination below, and the commencement of the œsophagus are seen at *i.*—

The pharynx has been lately described* as composed of a varied stratum of muscular fibres, lined by a membrane which is continued from the internal surface of the nose and mouth. From the pharynx the œsophagus passes downwards between the trachea, and the vertebræ. After the bifurcation of the trachea, it proceeds in contact with the spine, between the lamina of the mediastinum, to the diaphragm, which it passes through, and then terminates in the stomach.

The œsophagus is a flexible tube, which, when distended, is nearly cylindrical. It consists of a muscular coat externally, and an internal tunic evidently continued from that of the pharynx. These coats are connected by a cellular substance called the *Nervous Coat*,† which is remarkably loose, and allows them to move considerably upon each other. The muscular coat, which is very distinguishable from that of the pharynx, consists of two substantial strata of fibres; the exterior of which is nearly longitudinal in its direction, and the interior circular or transverse.

—The longitudinal fibres appear to arise in part from the posterior face of the cricoid cartilage, between the posterior crico-arytenoid muscles, and part from the lower end of the pharynx; they are disposed regularly around the œsophagus, and below are manifestly continuous with the longitudinal muscular fibres of the stomach. The first ring of the circular fibres, also seems to arise from the cricoid cartilage, and has been described as the crico-œsophageal muscle. There is no sphincter,

* See vol. i. p. 446.

† The *nervous coat*, is nothing but a structure of submucous cellular tissue, which connects the mucous membrane, as the subcutaneous does the skin, to the parts subjacent, and through which the nerves and blood-vessels ramify, before they spread minutely in the mucous membrane.—P.

at the junction of the œsophagus with the stomach as has been asserted by some anatomists.

—The muscular coat of the œsophagus is next in thickness to that of the pharynx, and thicker than that of any other portion of the alimentary canal.—

The internal coat of the œsophagus, resembling that of the fauces, is soft and spongy. It is covered with a very delicate cuticle, which Haller supposed to be too tender to confine the matter of variolous pustules, as he had never found these extending into the œsophagus. It is very vascular, and abounds with the orifices of mucous follicles, from which is constantly poured out the mucus that is spread over this surface. When the œsophagus is not distended, many longitudinal plaits are found in this membrane by the contraction of the circular or transverse fibres exterior to it. These plaits are calculated to admit readily of the distention which is requisite in deglutition. This tunic is continued from the lining membrane of the pharynx above, and terminates below in the villous coat of the stomach; from which, however, it is very different.

—The cuticle terminates by an irregularly fringed or festooned border at the cardiac orifice, where the œsophagus terminates, and is insensibly lost upon the mucous membrane of the stomach. The mucous membrane of the œsophagus, like that of the rectum (and unlike that of any other portion of the alimentary canal,) is united by a very loose cellular tissue to the inner face of the circular stratum of fibres, so that it may be withdrawn as a cylindrical tube from the muscular sheath in which it is contained.

—Experimenters upon living animals have asserted that they have seen the muscular coat, force by its contraction the mucous membrane downwards, so as to cause it to form a circular tumour, much like that of the mucous membrane of the rectum, in prolapsus ani.—

The blood-vessels of the œsophagus come from the aorta and those which are in the vicinity. The nerves are derived from the eighth pair. The lymphatic vessels are very abundant.

In the neck the œsophagus inclines rather to the left of the

middle line. As it proceeds down the back between the lamina of the mediastinum, it preserves the same course to the fourth dorsal vertebra, when it assumes the middle portion and proceeds downwards, with the aorta to its left, and the pericardium before it. About the ninth dorsal vertebra it inclines again rather to the left, and somewhat forward, to arrive at the aperture in the diaphragm through which it passes.

Throughout this course it is connected by cellular membrane to the contiguous parts; and this investiture of cellular membrane has been called its *External Coat.*

While the œsophagus is in the posterior mediastinum it is in contact with several small absorbent glands, especially when it first assumes a situation to the right of the aorta. These glands were formerly believed to be particularly connected with this tube, but they are now considered as belonging to the absorbent system. They are sometimes greatly enlarged.

Of the Stomach.

This most important organ, which occasionally exerts a powerful influence upon every part of the body, appears very simple in its structure.

It is a large sac, which is so thin when much inflated, that at first view it seems membranous, but upon examination is found to be composed of several lamina or coats, each of a different structure. It is of considerable length, but incurvated. It is much larger at one extremity than the other, and changes so gradually in this respect, that it would appear conical, if it were straight. It is not, however, strictly conical, unless it is greatly distended; for when moderately distended, a transverse section is rather oval than circular. It is, therefore, considered as having two broad sides or surfaces, and two edges, which are the curvatures. It has been compared by the anatomists of different nations to the wind sac of the musical instrument called the bagpipe.* The orifice in which the œsophagus terminates

* The student ought not to attempt to acquire an idea of the form of the stomach without demonstration, for a view of one moment will be more serviceable than a long description.

is at a small distance from its largest extremity, and is called *Cardia*. The orifice which communicates with the intestines is at the termination of its small incurvated extremity, and is called the *Pylorus*.

The two ends of the stomach being thus very different in size, are denominated the great and small extremities. The two curved portions of the surface are also called the great and small curvatures. The two flat portions of the surface or the broadsides, are called the anterior and posterior surfaces.

The situation of the stomach in the abdomen is nearly transverse: it lies principally in the left hypochondriac and epigastric regions, immediately below the liver. The great extremity of the stomach is in the left hypochondriac region, and the lesser extremity in the epigastric region, under the left lobe of the liver. The upper orifice, or *Cardia*, is nearly opposite to the body of the last dorsal vertebra; and owing to the curved form of the stomach, the other orifice, or *Pylorus*, is situated at a small distance to the right of that bone, and rather lower and more forward than the cardia: both orifices being in the epigastric region. The position of the stomach is oblique in two respects; it inclines in a small degree from above downwards, from the left to the right; and it also inclines downwards and forwards, from behind. Its two orifices are situated obliquely with respect to each other; for, if the stomach, when placed with its small curvature upwards, were divided into two equal parts by a vertical plane passing lengthways through it, they would be found on different sides of the plane.

As the œsophagus terminates in the stomach immediately after it has passed through an aperture of the diaphragm, it is evident that the stomach must be somewhat fixed at that place; but it is more movable at its other orifice; for the extremity of the duodenum, into which it is continued, is movable.

The stomach is connected to the concave surface of the liver by the reflection or continuation of the peritoneum which forms the lesser omentum. This membrane, after extending over each surface of the stomach, continues from its great curve in the form of the large omentum, and connects it to different parts,

especially to the colon. There are likewise folds of the peritoneum, as it passes from the diaphragm and from the spleen to the stomach, which appear like ligaments.

Notwithstanding these various connexions, the stomach undergoes considerable changes in its position. When it is nearly empty, and the intestines are in the same situation, its broad surfaces are presented forwards and backwards; but when it is distended, these surfaces are presented obliquely upwards and downwards, and the great curvature forwards. When its anterior surface is presented upwards, its orifices are considerably influenced in their direction, and the œsophagus forms an angle with the plane of the stomach.

The stomach is composed of four dissimilar lamina, which may be demonstrated by a simple process of dissection.

There is a first coat or external covering continued from the peritoneum: within this, and connected to it by delicate cellular substance, is a coat or stratum of muscular fibres: contiguous to these fibres, internally, is a layer of dense cellular substance, called a nervous coat; and last is the internal coat of the stomach, called villous or fungous, from the structure of its surface.

The external or first coat of the stomach, as has been already stated, is continued from the concave surface of the liver to the lesser curve of the stomach in two delicate lamina, which separate when they approach the stomach, and pass down, one on each side of it, adhering firmly to it in their course: at the opposite curve of the stomach they again unite to form the great omentum. The stomach is therefore closely invested by the peritoneum on every part of its surface except two strips, one at the lesser and the other at the greater curvature. These strips or uncovered places are formed by the separation of the lamina above mentioned, which includes a triangular space bounded by the stomach and these two lamina. In these triangular spaces, at each curvature of the stomach, are situated the blood-vessels which run along the stomach in those directions, and also the glands which belong to the absorbent vessels of this viscus. The peculiar arrangement of the lamina at this place is particularly calculated to permit the dilatation of the stomach. When it is

dilated, the lamina are in close contact with its surface, and the blood-vessels being in the angle formed by the adhesion of the two lamina to each other, are so likewise: when it contracts, the blood-vessels appear to recede from it, and the lamina are then applied to each other.

Where the peritoneum thus forms a coat to the stomach, it is stronger and thicker than it is between the liver and stomach. In a recent subject it is very smooth and moist, but so thin that the muscular fibres, blood-vessels, &c. appear through it. If it is carefully dissected from the muscular coat, it appears somewhat flocculent on that surface which adhered to the muscular fibres. It seems to be most abundantly furnished with serous vessels; but it has been asserted by Mascagni and Soemmering, that a large proportion of its texture consists of absorbent vessels. The cellular substance which connects this to the muscular coat, appears no way different from ordinary cellular membrane.

The *Muscular Coat* of the stomach has been described very differently by respectable anatomists; some considering it as forming three strata or fibres, and others but two. If the stomach and a portion of the œsophagus attached to it be moderately distended with air, and the external coat carefully dissected away, many *longitudinal* fibres will appear on every part of it, that evidently proceed from the œsophagus: these fibres are particularly numerous and strong on the lesser curvature of the stomach.—Beside the *longitudinal* fibres, there are many that have a *circular* direction, and these are particularly numerous towards the small extremity; but it has been doubted whether there are any fibres in the muscular coat of the stomach that go directly round it. The whole surface of the stomach, when the peritoneal coat is removed, appears at first view to be uniformly covered by muscular fibres; but upon close examination, there are interstices perceived, which are occupied with firm cellular membrane.

—The longitudinal or superficial fibres of the stomach, many of which can be traced from the esophagus over the cardiac orifice of the stomach, are grouped together so as to form a thicker and stronger layer along the lesser curvature of the

stomach; many of these, if traced with care, will be found continuous with the longitudinal fibres of the duodenum, and many which are terminated by insertion in the cellular coat of the stomach near the pylorus. The circular fibres constitute the sphincter muscle of the pylorus, by being thickened into a muscular band at the line of separation between the stomach and duodenum. There is another order of fibres called the oblique, which are few in number, spread over the left extremity or greater tuberosity. But it seems an unnecessary degree of refinement, to consider these other than the circular altered in their direction, by the expansion which that part of the stomach undergoes shortly after birth. They cannot well be studied except in cases where the muscular coat of the stomach is in a state of hypertrophy.

—The use of these oblique fibres, appears to be, to compress the great tuberosity of the stomach, and force the matters which it contains into the body of the stomach and towards the pylorus. The muscular fibres of the stomach are pale, and present in regard to *colour*, the appearance of ligamentous fibres, for which they were mistaken by Helvetius and Winslow. This appearance is common likewise, to the muscular fibres of the intestinal canal, and of the bladder.

—In the young infant, the shape of the stomach is more tubular, and like that of an intestine; its left or splenic pouch not having yet been formed. Hence vomiting occurs so much more readily in the child than in the adult, the axis of the stomach in the latter, corresponding at its two extremities more nearly with that of the cardiac and pyloric orifices.

—The cardiac orifice of the stomach is not provided with any sphincter, as it was thought to be by the ancients.—

In contact with the internal surface of the muscular coat is the *cellular stratum*, which has been called the *Nervous Coat* of the stomach. It is dense and firm, of a whitish colour, resembling condensed cellular membrane. It was considered as different from ordinary cellular membrane; but if air be insinuated into its texture, by blowing between the muscular and villous coats, while it connects them to each other, it exhibits the proper ap-

pearance of cellular substance. It, however, adds greatly to the general strength of the stomach, and the vessels which terminate in the villous coat ramify in it.

—The cellular coat is the most resisting of all the tunics of the stomach, and may be considered as the basis or frame-work of its structure. It is more closely united to the muscular coat on its outer face, than to the mucous on its inner. Its attachment to the latter, will be seen on close inspection, to be by means of a substratum of delicate cellular tissue.—

The internal coat of the stomach in the dead subject is commonly of a whitish colour, with a tinge of red. It is named villous, from its supposed resemblance to the surface of velvet. It has also been called fungous, because the processes analogous to the villi are extremely short, and its surface has a granulated appearance; differing in these respects from the internal surface of the intestines. It is continued from the lining membrane of the œsophagus, but is very different in its structure. Many very small vessels seem to enter into its texture, which are derived from branches that ramify in the nervous coat. It is supposed by several anatomists of the highest authority, to have a cuticle or epithelium; and it is said that such a membrane has been separated by disease. It ought, however, to be remembered, that the structure of the villous coat of the stomach and intestines, is essentially different from the structure of the cuticle.

The internal coat of the stomach is generally found covered, or spread over with mucus, which can be readily scraped off. This mucus is certainly effused upon it by secreting organs, and it has been supposed that there were small glandular bodies exterior to the villous coat, which furnished this secretion; but the existence of such bodies is very doubtful, as many skilful anatomists have not met with any appearance that could be taken for glands, except in a very few instances, which would not be the case if those appearances had been natural. Pores, perhaps the orifices of mucous follicles, and also of exhalent vessels, are very numerous, but no *proper* glandular masses are attached to them. Glands, as has been already said, are found in the triangular spaces between the lamina of the peritoneum at the great

and small curvatures of the stomach, but these evidently belong to the absorbent system.* Besides the mucus above mentioned, a large quantity of a different liquor, the proper *Gastric Juice*, or fluid of the stomach, is effused from its surface. It has been supposed that this fluid is furnished by the small glandular bodies believed to exist between the coats of this organ; but, admitting the existence of these glands, they are not sufficiently numerous to produce so much of it as is found, and it is therefore probable that this fluid is discharged from the orifices of exhalent vessels in the internal surface.

Much information respecting the gastric liquor has been obtained within a few years past by the researches of physiologists, and they are generally agreed that it is the principal agent in the effects produced by the stomach upon alimentary substances.†

As the muscular coat of the stomach frequently varies its dimensions, the villous and nervous coats, which have no such power of contraction, cannot exactly fit it. They therefore ge-

* The mucous coat of the stomach is, in its healthy state, thinner, softer, and more vascular in the cardiac half of the stomach, than in the pyloric. The villi are better developed in the pyloric region. The place of glands in the stomach is supplied mainly by muciparous follicles, which are microscopical in regard to size. In pathological conditions of the membrane, these follicles sometimes appear round, or ovular, globular or flattened, and are believed to be analogous in structure and function, to the blennogenous apparatus of Breschet. The mucus in the latter case, assisting to form the cuticle, a covering which does not extend farther down the alimentary canal than the cardiac orifice of the stomach, at which place it terminates, as Chaussier first observed, in a crescentic margin.—P.

† On this subject, the student may consult with advantage—

M. Réamur. In the Memoires of the Academy of Sciences for 1752.

John Hunter. London Philosophical Transactions for 1772; and also his observations on the Animal Economy, 1786.

Dr. Edward Stevens. Inaugural Thesis de Alimentorum Concoctione, Edinburgh, 1777.

The Abbé Spalanzani. Dissertations relative to Natural History, &c. The first volume of the English translation contains the author's dissertations on digestion, and also the first paper of Mr. Hunter, and the Thesis of Dr. Stevens, as well as an account of the experiments of Mr. Gosse of Geneva.

In addition to these, there are several interesting essays in the French, German, and Italian languages, a compilation of which is to be found in Johnson's "History of the Progress and present State of Animal Chemistry." See vol. i. p. 158.

nerally appear larger, and of course are thrown into folds or rugæ. These folds are commonly in a longitudinal direction; but at the orifices of the stomach they are arranged in a radiated manner, and sometimes they are observed in a transverse direction. They depend upon the contraction of the muscular fibres, and disappear entirely when the stomach is laid open and spread out.

At the lower orifice is a circular fold, which is permanent, and constitutes the valve denominated *Pylorus*. It appears like a circular septum with a large foramen in its centre, or like a flat ring. The villous and nervous coats of the stomach contribute to this, merely by forming the circular fold or ruga; and within this fold is a ring of muscular fibres, evidently connected with the circular fibres of the muscular coat of the stomach, the diameter of which at this place is not larger than that of an intestine: the fibres of this ring seem a part of the muscular coat projecting into the cavity of the stomach and duodenum. If a portion of the lesser extremity of the stomach and the adjoining part of the duodenum be detached, and laid open by a longitudinal incision, and then spread out upon a board, the internal coat can be very easily dissected from the muscular, and the pylorus will then appear like a ridge or narrow bundle of muscular fibres, which run across the extended muscular membrane. It is evident that when the parts are replaced so as to form a cylinder, this narrow fasciculus will form a ring in it. Thus arranged the circular fibres can readily close the lower orifice of the stomach.

The pylorus separates the stomach from the intestine duodenum; and this separation is marked exteriorly by a small circular depression, which corresponds exactly with the situation of the pylorus.

The arteries of the stomach are derived from the *Cœliac*, the first branch which the aorta sends off to the viscera of the abdomen. This great artery, immediately after it leaves the aorta, is divided into three branches, which are distributed to the stomach, the liver, and the spleen, and are called the *Superior Coronary* or *Gastric*, the *Hepatic* and the *Splenic*. Besides the first

mentioned branch, which is distributed principally to the neighbourhood of the cardia and to the lesser curvature, the stomach receives a considerable branch from the hepatic, which passes along the right portion of its great curvature, and has been called the right gastro-epiploic, and another from the spleen, which passes along the left portion of the great curvature, and has been called the left gastro-epiploic. In addition to these branches, the splenic artery, before it enters the spleen, sends off several small arteries to the great extremity of the stomach, which are called vasa brevia.

These vasa brevia generally arise from the main trunk of the splenic artery, but sometimes from its branches.

The veins which receive the blood from these arteries have similar names, and pursue corresponding courses backwards: but they terminate in the vena portarum.

The absorbent vessels of the stomach are very numerous and large: they pass to the glands which are on the two curvatures, and from thence to the thoracic duct. It is an important fact relative to the history of digestion, that there are good reasons for doubting whether chyle commonly passes through them, notwithstanding their number and size.*

The nerves of the stomach are derived from the two great branches of the par vagum, which accompany the œsophagus and are mostly spent upon this organ, and form branches from several plexuses, which are derived from the splanchnic portions of the intercostal nerves.

—The par vagum nerves form a plexus round the cardiac orifice, and are distributed, the left on the anterior, and the right on the posterior face of the stomach.

—These nerves can be traced into the muscular coat of the stomach, and some of them as far as the duodenum.

—The section of these nerves, paralyzes the muscular coat of the stomach. These nerves serve to connect the stomach, functionally, to the œsophagus, to the pharynx, larynx, lungs and heart,

* Sabatier, however, in one subject observed white lines on the stomach, which he suspected to be lacteals. See his account of the absorbents of the stomach.

The nerves which the stomach receives from the plexuses of the abdomen, in like manner connect it with the abdominal viscera.—

Of the Intestines.

The intestines form a continued canal from the pylorus to the anus, which is generally six times the length of the subject to which they belong.* Although the different parts of this tube appear somewhat different from each other, they agree in their general structure. The coats or lamina of which they are composed, are much like those of the stomach, but the peritoneum which forms their external coat does not approach them in the same manner; nor is it continued in the form of omentum from the whole tube, there being only a certain portion of intestine, viz. the colon, from which such a process of peritoneum is continued.

The *Muscular Coat*, like that of the stomach, consists of two strata, the exterior of which is composed of longitudinal fibres, which adhere to the external coat, and do not appear very strong. The other stratum, consisting of circular or transverse fibres, is stronger, as the fibres are more numerous. It is observable that they adhere to the longitudinal fibres; and they seldom, if ever, form complete circles.

The cellular substance immediately within the muscular fibres resembles the nervous coat of the stomach in its firmness and density. It is likewise so arranged as to form many circular ridges on its internal surface, which support to a certain degree the permanent circular plaits of the internal coat, called valvulæ conniventes.

* This is a rule a long time admitted among anatomists, making the small intestines twenty-four to twenty-eight feet in length, and the large intestines about six more. But this mode of measurement is found to be totally defective when applied to comparative anatomy, and Dr. Horner has found it applicable only to man, when the intestine is left attached to the mesentery; for, as he observes, "if it be cut off and straightened, the small intestine will measure thirty-four feet, which, added to the eight feet which the large intestine measures when treated in the same way, will amount in all to forty-two feet. If to the estimate of this length are added what is lost by the doubling of the mucous coat, the entire length of surface must amount to nearly sixty feet, at least in many subjects."—P.

The inner surface of the internal coat has been commonly compared to that of velvet, and the coat is therefore called villous; but there is certainly a considerable difference between these surfaces; for if a portion of the small intestine be inverted, and then suspended in perfectly transparent water, in a clear glass, and examined with a strong light, it will appear like the external surface of the skin of a peach, on which the down or hair-like processes are not so close as those on velvet. On this surface, between the villi, there are many orifices of mucous follicles and of exhaling vessels.* Exterior to the villous coat, many very small glandular bodies are sometimes found, which are called after their describers Glandulæ Brunneri and Peyeri.

The internal coat of the upper portion of the interstitial tube is arranged so as to form a great number of transverse or circular folds or plaits, called *Valvulæ Conniventes*, which do not generally extend round the intestine, but are segments of circles; they are so near each other, that their internal edges, which are very movable, may be laid upon the folds next to them, like tiles or shingles. It is evident that this arrangement of the internal coat must add greatly to its length. This coat is extremely vascular, so that in the dead subject it can be uniformly coloured by a successful injection. The minute structure of it has been the subject of very diligent inquiry. There can be no doubt but that an immense number of exhaling and of absorbent vessels open upon it; but there are many different opinions respecting the termination of one set of vessels and the commencement of the other

A very interesting account of the *Villous Coat* was published in 1744, by Lieberkuhn, who was considered by his contemporaries as a most expert practical anatomist, and was also very skilful in microscopical examinations, for which he was particularly calculated, as his natural powers of vision were uncom-

* It appears clearly, from the account of Lieberkuhn, that the orifices or terminations of the arteries on the intestines, are distinct from the follicles; for he forced injections from the arteries into the cavity of the intestines, and found the follicles still filled with mucus. He then urged the injection further, and filled the follicles, or forced the mucus out of them.

monly strong. In his essay he refers to his preparations, which were at Berlin, and which appear to have excited great surprise in the minds of the members of the Academy of Sciences of Prussia, at a time when one of the first anatomists of Europe, the celebrated Meckel, was of their number.

According to this account the internal surface of the small intestines abounds with villi, and with the orifices of follicles. These villi, are about the fifth part of a line in breadth. In each of them is a cavity filled with a soft spongy substance, which has one or more orifices communicating with the intestines, and from which also proceeds a lacteal vessel. On the membrane which forms this cavity, blood-vessels are most minutely ramified. This cavity he calls an ampullula, and supposes it to constitute the principal part of the villus. By injecting the arteries of the intestine, he was able to pass a fluid through the ampullula into the cavity of the gut; he kept a stream of air in this way passing through the ampullula until it was nearly dry and stiff, and then laid it open with a fine instrument. From the appearances which then presented, he inferred that the cavity of the ampullula was occupied with a spongy or cellular substance. Around each villus he found a number of mucous follicles, which often were filled with a tenacious mucus: and distinct from these must be the exhalent orifices, which discharged a fluid injected by the arteries without passing through the mucous follicles.

Lieberkuhn died early, and left but one essay on this subject, which was originally published in Holland, in 1744, but has been republished by the Academy of Berlin, in their Memoirs; and also by Mr. John Sheldon, of London.

This account of Lieberkuhn appears to have been admitted by Haller: but it has been rigidly scrutinized by some of the anatomists of London, who were particularly interested with the subject; as they had paid great attention to the absorbent system, and were very successful in the investigation of it.

The late Mr. Hewson, whose opinion is entitled to the greatest respect, rejected the idea of the ampullula, and believed that the villi are composed of net-works of lacteals, as well as

arteries and veins; although he added that "this is the only circumstance concerning these parts in which he should differ from this very acute observer."*

Mr. Sheldon agrees with Lieberkuhn: but Mr. Cruikshank asserts, that, "in some hundred villi, he has seen the lacteals originate by radiated branches, whose orifices were distinct on the surface of the villus." The villus being transparent, when the intestine was immersed in water, these branches, filled with chyle, could be seen passing into the lacteal. Mr. Cruikshank therefore supposes that Lieberkuhn was mistaken, and that the spongy cavity, or ampullula, was the common cellular membrane, connecting together all the arteries, veins, nerves, and lacteals.

It seems probable, from Mr. Cruikshank's statement, that Dr. William Hunter held the same opinion with himself. And there is also reason to believe that Monro the second, who studied anatomy at Berlin, held a different opinion from Lieberkuhn.

Mr. Fyfe, who has been much employed in the investigation of the absorbent system, and must be perfectly acquainted with the preparations of Monro, asserts that each lacteal takes its rise upon one of the villi by numerous short radiated branches, and each branch is furnished with an orifice for imbibing chyle.

Several of the late French writers adopted the opinion of Lieberkuhn; but his countryman Soemmering gives a different account of the subject. He says, that, besides the blood-vessels, each villus consists of a fine net-work of absorbent vessels, whose orifices may be distinctly recognised; and that from six to ten of these orifices are sometimes discovered.

Mascagni, who has published the most extensive work upon the absorbent system that has yet appeared, supposes Lieberkuhn to have been mistaken, and confirms the description of Hewson: but he also agrees with Hewson in his opinion of the general accuracy of Lieberkuhn.

Notwithstanding their differences respecting the origin of the lacteals, all these observers have agreed, that the orifices which

* See Hewson's Experimental Inquiries, vol. 2, page 171.

communicate with the lacteals are on the villi; and that these villi contain also very fine ramifications of blood-vessels. They have also agreed that the surface of the intestines in the intervals of the villi seems occupied with the orifices of ducts or of exhalent vessels.*

Division of the Intestines.

Although there is a considerable degree of uniformity in the structure of the intestinal canal, different parts of it are very distinguishable from each other by their exterior appearance, by their size, their investments, and their position.

The first division is into two great portions, which are very different from each other in their diameter and length, as well as their situation; the first portion being much smaller in diameter, and near four times the length of the other.

These portions are therefore known by the names of *Great and Small Intestines*, and the line of separation between them is very strongly marked; for they do not gradually change into each other, but the alteration in size and in exterior appearance is very abrupt, and their communication is not perfectly direct. A considerable portion of the *Great Intestine* is fixed immovably in the abdomen, while a large part of the *Small Intestine* is very movable.

Each of these great portions of the intestinal tube is subdivided into three parts. Thus, in the *Small Intestine*, there is a piece at the commencement called *Duodenum*, a great part of which has no coat from the peritoneum, and is immovably fixed in one situation; while all the remainder of the small intestine has a uniform covering from the peritoneum, and is very movable. This last piece, notwithstanding its exterior uniformity, is considered as forming two parts. The uppermost two-

* On this subject the student will consult with advantage, Hewson's Experimental Inquiries, vol. 2; Sheldon's History of the Absorbent System, part 1st; Cruikshank on the Anatomy of the Absorbing Vessels; and the Historia Vasorum Lymphaticorum Corporis Humani, of Mascagni.

—The more recent investigations of Beclard, Meckel, Breschet, Müller, Dr. Horner and others have a tendency to disprove the existence of absorbing orifices on the surface of the villi; vide, Absorbent System.—P.

fifths from one part, which is called *Jejunum;* and the remainder is called *Ileum.* The *Great Intestine* commences in the lower part of the right side of the abdomen, and after proceeding up that side, crosses over to the left, along which it descends to the lower part again, when by a peculiar flexure it proceeds to the centre of the posterior margin of the pelvis, from which it passes down to the anus. A short portion of this intestine, which is above its junction with the ileum, is called *Cæcum;* the part which proceeds from this, round the abdomen, is called *Colon;* and the portion which is in the pelvis is called *Rectum.*

Of the Small Intestines.

Previous to the description of the small intestines, it is necessary to observe, that the *Mesocolon,* or process of the peritoneum connected to the transverse portion of the colon, forms a kind of movable and incomplete septum, which divides the abdomen into an upper and lower apartment. Above this septum are the stomach, with the commencement of the duodenum, the liver, and the spleen; below it, that portion of the small intestine which is called jejunum and ileum, makes its appearance. The portion of the intestine which passes from the stomach to the jejunum, and is called *Duodenum,* is so much involved by the mesocolon, that the greatest part of it cannot be seen without dissecting the mesocolon from its connexion with the back of the abdomen.—For the duodenum proceeds backwards from the pylorus, and passing down behind the peritoneum, enters a vacant space between the two lamina of the mesocolon; it proceeds for some distance in this space, and then emerges on the lower side of the mesocolon. Here the duodenum terminates, and the small intestine then is invested by the peritoneum in such a manner as to form the mesentery, which continues with it throughout its whole course to the great intestine. This portion of the intestine, although very uniform in its exterior appearance, as has been observed before, is divided into *Jejunum* and *Ileum:* the jejunum being the upper portion, which begins at the mesocolon; and the ileum the lower portion, which opens into the great intestine.

Of the Duodenum.

The length of this intestine is equal to the breadth of twelve fingers, and hence its name. It is very different from the rest of the small intestine, not only as respects its position and investment by the peritoneum, but on account of its connexion with the liver and pancreas, by means of their excretory ducts, which open into it. From this connexion with these glands, probably, all the peculiarities of its position are to be deduced.

When the stomach is in its natural situation, the pylorus is at some distance from the back of the abdomen. The duodenum proceeds backwards from this point, and passes near the neck of the gall-bladder, being here connected with the small omentum; it then curves downwards, and descends before the right kidney, sometimes as low as the lower part of it; then it curves again, and passes over to the left: after it has arrived at the left side of the spine, at the second or third lumbar vertebra, it projects forwards and downwards to form the jejunum. The only portion of this intestine which is movable, is that which is in sight as it proceeds immediately from the pylorus, being about an inch and a half, or two inches in length. The remainder is connected to the back of the abdomen, and lies between the two lamina of the mesocolon. In its progress it passes before the aorta and the vena cava, but the principal branch of the vena portarum is before it.

The duodenum is larger in diameter than any other part of the small intestines, and has a stronger muscular coat. Its general situation admits of great dilatation, and it has been called a second stomach, (*ventriculus succenturiatus.*) Its internal coat is strictly villous in the anatomical sense of the word; and its folds, the valvulæ conniventes, begin at a small distance from the pylorus. The orifices of many mucous ducts are to be seen on its surface. It is supposed that some of these are the terminations of ducts from the glands of Brunner, which sometimes appear in the villous coat, or very close to it exteriorly; being small flat bodies, with a depression in the centre, and a foramen in the depression. They are sometimes very numerous

at the upper extremity of this intestine, and diminish gradually towards the other extremity.

The biliary and pancreatic ducts open posteriorly into the duodenum, rather above the middle of it. The orifice of these ducts is generally surrounded by a small tubercle, which is oblong, somewhat rounded at one extremity, and pointed at the other. Sometimes this orifice is in a plait, like one of the valvulæ conniventes. Most commonly the two ducts unite before they perforate the coat, so as to form but one orifice; and sometimes they open separately, but always very near to each other.

Absorbent vessels, which contain chyle, are found on the duodenum.

The Jejunum and Ileum

Are situated in the abdomen very differently from the duodenum. When the cavity is opened, and the omentum raised, they are in full view; and every portion of them except the two extremities and the parts near them, can readily be moved. This freedom of motion is owing to the manner in which they are invested by the peritoneum; or, in the technical language of anatomy, to the length of their mesentery. They agree in their structure with the general description of the small intestines, but their muscular coat is rather weaker than that of the duodenum. The valvulæ conniventes are very numerous and large in the upper part of the tube, or jejunum; and gradually diminish in number, until they finally disappear in the lower part of the ileum. The villous coat is in perfection in the jejunum, the villi being more conspicuous there than in any other part of the intestinal tube. There are frequently found, exterior to this coat, but intimately connected with it, many small glandular bodies of a roundish form, which are often clustered together at that part of the intestine which corresponds with the interstice of the lamina of the mesentery. They are called Peyer's glands, after the anatomist who first described them; and are supposed, like the glands of Brunner, to secrete mucus. If a portion of the jejunum be inverted, and moderately distended with air, these bodies appear very distinctly in it, dispersed at small distances from

each other. In the ileum they appear in small clusters, which often have the appearance of disease.

No natural line of separation for distinguishing the jejunum and ileum from each other, is to be found; but these names are still retained; and, therefore, a rule laid down by Winslow is generally adopted, viz. to name the first two-fifths of the tube jejunum, and the remainder ileum. There are, however, some important differences between these portions of the intestine.

In the jejunum, the valvulæ conniventes are so numerous, that they lie in contact with each other, as shingles on the roof of a house; in the ileum they gradually diminish in number, and finally disappear. In the jejunum, the villi are much stronger than they are in the ileum.

It is very difficult to acquire a precise idea of the arrangement of this part of the intestinal tube, while it is in the abdomen, especially if it be much distended; but if it be separated at each extremity from the intestine with which it is connected, and the mesentery cut off from the back of the abdomen, and the whole then spread out upon a flat surface, it will appear, as has been already said, that the intestine is arranged so as to form a semicircle, or large curve; the concavity of which is opposite to the back of the abdomen, while the convexity presents forward. It will also appear, when thus placed upon a table, that the intestine, while connected with the mesentery, is laid into many folds. It has been supposed, that the middle portion of the mesentery, and the intestine connected with it, is generally in the umbilical region; and the two portions on the sides of it are in the iliac regions; but their situation in the abdomen varies considerably at different times. When the viscera of the pelvis are empty, a large portion of the small intestine is in the pelvis; but when those viscera are filled, the intestine is in the general cavity of the abdomen.

The Mesentery

Is a process of the peritoneum, which is formed in the manner of a plait or fold, and of course consists of two lamina. These lamina proceed from the back part of the abdomen, and are so

near to each other, that they compose one substantial process; having cellular and adipose substance, blood-vessels and nerves, with absorbent or lacteal vessels and their glands between them.

The form of this process, when it is separated from the back, and the intestines are detached from it, is somewhat semicircular: that portion of its margin or edge which corresponds to the diameter of the semicircle, is connected to the back of the abdomen, and called the root of the mesentery; the edge, which is the circumference of the semicircle, is connected with the intestine. The edge connected with the back of the abdomen is commonly about five or six inches in length: the semicircular edge, instead of extending fifteen or eighteen inches, the ordinary proportion, is attached to a portion of intestine sometimes twenty-four feet in length. The mesentery, on account of this great difference between its diameter and circumference, has been compared to the ruffle of a shirt sleeve; its roots being taken for the plaited edge of the ruffle, and the circumference for its loose edge. But the comparison is not precisely accurate; for the mesentery is not plaited at its root, but perfectly smooth, and free from every kind of fold. It begins to enlarge towards its circumference, and enlarges to that degree that it falls into plaits or folds: precisely such as would exist in a semicircular piece of membrane about six inches in diameter, if a number of simple incisions, of about an inch and a half in length, were made in a radiated direction from the circumference, and if portions like a sextant or quadrant were taken from a circular membrane three inches in diameter, and united by their edges to these incisions, so that their circumference might be continuous with the circumference of the large semicircular piece. In this case, the portions like quadrants or sextants would assume a folded position like the edge of the mesentery, while the middle of the semicircular piece would preserve its regular form without folds; as is the case with the mesentery at some distance within its circumference. By many additions of this kind, the circumference of a membrane, which was originally a semicircle of five or six inches, may be extended so as to exceed greatly that of the mesentery It seems of course impossible to form an accurate model of the

mesentery with a *single* piece of membrane or paper; but it may be easily made with clay, or any ductile substance. A model of this kind must necessarily be folded after the manner of the mesentery; and its circumference, like the mesentery, would appear as if formed of portions of the circumference of smaller circles united to each other.*

The root of the mesentery commences with the jejunum on the lower side of the mesocolon, at the left of the spine, and extends downwards near to the right iliac region, crossing the spine obliquely. When it is examined in its natural situation, the peritoneum is found continued from the back of the abdomen to the intestine; it then surrounds the intestine, and continues from it to the back of the abdomen again. There must therefore be two lamina of peritoneum in the mesentery, and there must be a small portion of intestine answering to the interstice between these lamina which is not covered by the peritoneum. The blood-vessels, and absorbents, or lacteals pass most commodiously to the intestines between these lamina; for they are connected with large trunks that lie on or near the spine, and the root of the mesentery commences there.

The glands connected with the lacteals or absorbents are very conspicuous in the mesentery, and are commonly called mesenteric glands. They are of different sizes, from more than half an inch to one or two lines in diameter. They are very numerous, and scattered irregularly, but are seldom observed very near to the intestine. They are often enlarged in consequence of disease, especially in children.

The nerves of the small intestines which are derived principally from the superior mesenteric plexus, are also to be found here.

The adipose matter between the lamina of the mesentery is very often in large quantity, but varies, in proportion to the general quantity of adeps in the subject.

* A model, upon the plan first mentioned, was invented by Dr. J. G. Shippen. It has been proposed, I believe by M. Gavard, to make one with a single piece of buckskin, of a semicircular form, by stretching it at the circumference.

OF THE GREAT INTESTINES.

The Cæcum and Colon

Are very different from the small intestines in many respects. They are much larger in diameter; their external surface is marked by three longitudinal bands of light colour, which extend the greatest part of their length, and are placed nearly at equal distances from each other; the spaces between these bands are marked by transverse indentations, which pass from one band to the other, at short but unequal distances. At these indentations the coats of the intestine are pressed inwards, as if a fine thread had been drawn round it externally, while the spaces between them are full and tumid, and on this account are called cells.

The great intestine, with these appearances, begins, as has been already observed, in the right iliac region, by a rounded end which rests on the fossa or concave surface formed by the costa of the ileum; from this it is continued upwards in the right lumbar region, anterior to the kidney, called *ascending colon*, until it arrives near the liver, when it forms a curve, called *the arch of the colon*, and passes directly across the abdomen to the left side. In this course it approaches so near to the under side of the liver, that it is often in contact with it, and with the gall-bladder, which, after death, tinges it with a yellow colour. On the left side it passes down the lumbar region, *forming the descending colon*, before the kidney, to the left iliac region; here it is curved so as to resemble the Roman letter S, inverted, called the *sigmoid flexure;* this curve generally carries it to the right side of the spine, and then brings it back to the centre of the sacrum. Here the intestine changes its course, and passing into the pelvis, continues downward, in contact with the sacrum and coccyx, and partaking of the curvature of those bones, until it terminates at the anus, where it is connected with the sphincter and levator ani muscles.

About two inches from the commencement of the great intestine, the ileum opens into it laterally; and all that portion

which is between its commencement and the insertion of the ileum is termed *Cæcum,* or the blind intestine: that part of the great tube, which is included in its course from the insertion of the ileum to the posterior part of the brim of the pelvis, is called *Colon;* and the remainder, or the part which is contained in the pelvis, is termed *Rectum.*

The *Cæcum* is nearly as wide as it is long; it is fixed in the right iliac fossa by the peritoneum, which invests it so that the great body of the intestine projects from the surface of the fossa covered by the peritoneum; but a portion is in close contact with the surface, and connected to it by the cellular membrane. Its external surface covered by the peritoneum, is marked by two of the bands or stripes before mentioned, which proceed on it lengthways. These bands are in full view, but the third band is generally on that part of the intestine which rests on the iliac fossa, and is therefore out of sight. At the rounded extremity of the cæcum, situated anteriorly and internally, is a small process resembling an earth-worm in form and size: this is therefore called, *Appendicula Vermiformis.* It is hollow, and communicates with the cavity of the cæcum, has its other extremity closed up. It is composed of the same number of coats and has the same structure as the great intestine: its length varies from two to four inches.

—After the stomach, the cæcum may be considered the largest portion of the intestinal canal.

—In the fœtus its diameter appears to be nearly the same as that of the adjoining part of the colon, and its subsequent increase in diameter over that of the colon, appears to be mainly owing to the stagnation of the fæcal matters, in consequence of the dependent position of this part of the large intestine, and the transverse direction by which the contents of the ileum are discharged into it.

—The cæcum varies much, however, in different persons, in regard to its length as well as its diameter.

—Retentions of the fæcal matter often take place in it, in cases of constipation, which have frequently been mistaken for inflammation of the bowels.—

The longitudinal bands above mentioned commence at the junction of the appendix with the cæcum, and continue throughout the extent of the colon. They appear to be formed by some of the longitudinal fibres of the muscular coat, which are arranged close to each other. These fibres seem to be shorter than the coats of the intestine, and the interior coats adhere firmly to them. Thus are produced the indentations and cells; for if the bands are divided transversely, the indentations disappear, and the surface of the intestine becomes uniform. One of these bands is covered by the mesocolon.*

The circular or transverse fibres of the muscular coat of the *cæcum* and *colon* are very delicate, and not numerous.

The internal coat differs materially from that of the small intestines, although at first view they seem to resemble each other; for if a portion of the ileum and of the colon be inverted and suspended in water, no villi can be seen with the naked eye on the internal coat of the colon, while those of the ileum are very visible. The glands exterior to this coat are larger than those on the small intestines.

Instead of valvulæ conniventes, are the ridges made by the indentations or depressions above described, which separate the incomplete cells from each other. These ridges differ essentially from the valvulæ conniventes, because all the coats of the intestine are concerned in their formation, whereas the valvulæ conniventes are formed by the villous coat only: they also project into the cavity of the intestine, while the valvulæ are laid on its surface. They pass only from one longitudinal band to another, and, in consequence of this, the cells are small, and the position of each band is very evident when the intestine is laid open.

The communication of the ileum with the great intestine has been already stated to be on the left side of it, about two inches from its commencement. The aperture is so constructed, that

* In the fœtus, no cells are visible in the colon. Their developement appears to be owing to the growth of the longitudinal fibres not taking place so rapidly in regard to length, as that of the other coats; which necessarily causes the crimping of the latter into folds, and the formation of cells.—P.

it is considered as a valve, and is called the valve of Bauhin, or of Tulpius, after the anatomists who have described it.* The appearance of the aperture is as follows: If the cæcum, with a small portion of the ileum and of the colon may be separated from the other intestines, and kept in an inflated state until it be so dry as to preserve its form when opened, and then if the cæcum and colon be laid open opposite to the aperture of the ileum, a large transverse ridge, resembling some of the ridges or folds just described, will be seen projecting into the cavity of the intestine. In the internal edge of this fold is a long slit or opening, which forms the communication between the two intestines. It is obvious that the form of this fold must be that of a crescent; and that its two surfaces with the slit between them, must have the appearance of two lips, which would readily permit a fluid or substance of soft consistence to pass from the ileum into the great intestines, but must impede, if not prevent, its passage back; especially if the large intestines were distended, as then the lips would be pressed against each other.

When the peritoneal coat is dissected from each of the intestines at their place of junction, and this structure is then examined *from without*, it appears as if a transverse or half circular indentation had been formed by the villous coat of the great intestine, and that the internal coat of the extremity of the ileum was pressed into this indentation, and united to the internal coat of the great intestine which formed it; while there was a slit both in the indentation and in the end of the ileum, which formed a communication between the cavity of the great intestine and the ileum. The longitudinal fibres of both intestines, as well as their external coats, seemed to be united, so as to form a common cover for them; while the circular fibres were blended in the two portions of the indentation which form the lips of the orifice.

This orifice is, of course, transverse with respect to the intestine. It has been observed, that there was a difference in

* Posthius in 1566; Vidus Vidius about 1569; Alberti in 1581; and Varolius, who died 1575, each lay claims to the discovery of it. Bauhin's claims are in 1579.—H.

the thickness and strength of the two lips or valves; that the lower valve was the strongest and appeared to have the largest proportion of muscular fibres in its composition. At the extremities of the orifice, and near each end of the fold or ridge, are tendinous fibres, and which give strength to the structure: they are called the Retinacula of Morgagni, as they were first described by that anatomist.

There is a great reason for believing that this valve cannot prevent the retrograde motion of the contents of the intestines in all cases; for in some instances of hernia and of colic, matter perfectly stercoraceous has been vomited, and the probable inference from such a state of the ejected matter is, that this matter has been in the large intestines. It is also said, that suppositories and enemata have been discharged by vomiting.

On the right and left sides of the abdomen, the colon is in close contact with the posterior surface of the cavity. The peritoneum which covers this surface extends over the intestine also, and thus retains it in its position. The great arch of the colon, which is loose and moves far from the back of the abdomen, is invested by the two lamina of the omentum, which, after surrounding it, unite again and form the mesocolon. Connected with the exterior surface of the colon are many processes, composed of adipose membrane, varying in length from half an inch to an inch and a half: these appear to be of the nature of the omentum, and are therefore generally denominated *Appendices Epiploicæ.*

The Rectum.

After forming the sigmoid flexure, the colon terminates; and the rectum begins opposite to the lower surface of the last lumbar vertebra, and nearly in contact with it; from this it proceeds downwards, forming a curve like the sacrum, until it terminates at the anus; where it is invested with the muscles called the sphincter and levator ani. It is called rectum, because in this course it is supposed not to incline to either side; but it is often found on one side of the middle line.*

* Morgagni and Haller supposed it to be commonly on the left of the middle line, and Sabatier on the right.

This intestine being in contact with the posterior surface of the pelvis, is covered, on its anterior surface only, by the peritoneum which lines the posterior surface of the pelvis; and it is fixed in this situation by the peritoneum, as the colon is on the right and left sides of the abdomen, but more loosely; and, therefore, the term *Mesorectum* has sometimes been applied to that portion of the peritoneum which is analogous to the mesentery and mesocolon. The peritoneum does not extend to the end of the rectum; for it is reflected at the lower part of the pelvis from the rectum to the bladder, or uterus, and does not line the bottom of the pelvis; so that the lower part of this intestine, as well as of the other viscera of the pelvis, is below the peritoneum, and not connected with it.

The muscular coat of the rectum is much thicker and stronger than that of any other intestine. The strata of longitudinal and circular fibres which compose it are very distinct from each other. The longitudinal fibres are most numerous, and terminate at the insertion of the fibres of the levator ani muscle.

The lower circular fibres are intimately connected with the sphincter ani.

—The circular muscular fibres at the end of the rectum, are so thickened as to form a sort of annular muscle, which projects into the cavity of the intestine, like the pylorus of the stomach. It is attached to the proper sphincter muscle below, by cellular tissue, and like it and the muscles of the pharynx at the other extremity of the canal, is in a great measure under the control of the will, being supplied in part with nerves from the cerebro-spinal system. It aids the sphincter in retaining the fæces in the pouch of the rectum.

—The three longitudinal muscular bands of the colon at the lower edge of the sigmoid flexure, separate into fasciculi, which are distributed as they descend round the circumference of the intestine, and form a thick uninterrupted layer round the rectum. The longitudinal fibres of the rectum have been shown by Professor Horner, to terminate in delicate tendons, which pass between these two sphincter muscles, *internal and external*, and turn upwards and inwards to be inserted on the inner face of the

mucous membrane of the rectum. Opposite the lower edge of the internal sphincter, the mucous membrane is thrown into a number of plaits or folds, in which the same anatomical observer has pointed out a number of irregular valvular pouches which open upwards. These when diseased become a source of intolerable itching and irritation, which attracted the attention of Dr. Physick, who was in the habit of relieving the suffering they produced by their excision.*

The internal coat is very vascular, but the villous structure is not apparent. Mucous follicles are also very numerous; and there are likewise some distinct glandular bodies exterior to this coat, which vary in size in different subjects.

—The mucous membrane of all the large intestines, when examined with the microscope under water, present scarcely any appearance of villi, but exhibit every where, slight honey-comb-like depressions, somewhat analogous to those of the stomach. It is strewed with a multitude of follicles, (*tanquam stellæ firmamente*, Peyer,) depressed and perforated in their centre, as seen in Fig. 47, p. 69; and which in many subjects, especially old men, present at their orifices the appearance of black spots.—

The quantity of mucus discharged from the rectum in certain cases of disease, is sometimes very great. The internal coat, in consequence of the contraction of the circular fibres exterior to it, sometimes forms longitudinal folds, which have been called its columns; these often disappear when the intestine is opened lengthways and spread out. By the contraction of the longitudinal fibres, the internal coat is often thrown into folds or doublings, that must assume a transverse or circular direction; they occasionally pass down through the sphincter, and form the prolapsus ani. The rectum is most plentifully supplied with blood-vessels, to be described hereafter; and it may be observed, that, on the lower part of the internal coat, the veins are particularly numerous.†

* For an excellent account of these parts, see article *Anus*, by Dr. R. Coates, in the American Cyclopedia of Med. and Surg. Philadelphia.—P.

† No intestine in proportion to its size, receives so much blood as the rectum, and the veins at its lower part not unfrequently exist in the form of a plexus.—P.

The internal coat of the rectum terminates abruptly just within the anus, and is united to a production of the skin, which, like the covering of the lips, is very delicate and vascular, and has an epithelium, or very thin cuticle, spread over it. The levator and sphincter ani muscles, with which the termination of the rectum is invested, are described in the first volume.

The *Absorbents of the Intestines*, are commonly denominated *Lacteals.** They originate on the internal surfaces of these viscera, as has been already described. After passing through the lymphatic glands, which are so numerous on the mesentery, they generally unite and form one of the great trunks which compose the thoracic duct. It is asserted, that some of the absorbent vessels of the lower intestines unite to the lymphatics of the loins.

The *Nerves of the Intestines* are principally derived from the intercostals, or great sympathetics. From each of these nerves, while they are in the thorax, an important branch, called the ramus splanchnicus, arises. These splanchnic branches pass through the diaphragm, and are the chief contributors to the ganglions and plexus formed in the abdomen. A plexus derived from this source surrounds the superior mesenteric artery, and another the inferior mesenteric; and from these proceed the nerves of the intestines.

The Omentum

Requires a separate description, although several circumstances connected with its structure have been already noticed. It often varies in its position; but when it is rendered firm by a quantity of adipose matter, it is spread over the intestines like an apron, extending from the lower edge, or great curvature of the stomach, towards the bottom of the abdomen.

As has been already said, it is an extension of the peritoneum, in two lamina, from the concave surface of the liver to the lesser

* The Lacteals were first observed by Erasistratus and Herophilus, of the school of Alexandria, during the reign of the Ptolemies; and subsequently by Aselli, of Pavia, in 1622, the knowledge of them having been lost for 1900 years.—H.

curvature of the stomach; and these lamina, after surrounding the stomach, come in contact with each other near its great curvature. From this portion of the stomach, from the commencement of the duodenum, and also from the spleen, the *Omentum*, composed of two lamina, descends over the colon and the small intestines more or less low into the abdomen; it is then folded backwards and upwards, and is continued until it meets the great arch in the colon: here the lamina again separate and enclose that portion of the intestine, on the posterior side of which they again approach each other, and form a membrane like the mesentery, of two lamina, which passes from the concave or posterior surface of the colon to the back of the abdomen, where it is continued into the membrane which lines that surface. This last portion is the *Mesocolon:* the portion between the liver and stomach is called the *Omentum of Winslow*, or the lesser omentum; and the great portion between the stomach and colon is called the *Great Omentum*, or the omentum gastro colicum. There is also a process of peritoneum continued from that portion of the colon which is on the right side of the abdomen, and from the cæcum, which extends to some distance; it is formed of two lamina, that compose a cavity of an angular form. This has been called the *Omentum Colicum*.

The great and small omentum, with a portion of the peritoneum on the back of the abdomen, form a sac, which encloses a distinct cavity in the abdomen. The anterior part of this sac is composed of two lamina, and between these lamina are the stomach and the great arch of the colon. This cavity formed by the two omenta, communicates with the general cavity of the abdomen by a foramen of a semicircular form, called the Foramen of Winslow, which is behind the great cord of the vessels that go to the liver.

The omentum is so delicate in structure, that when free from fat, it is very liable to laceration, merely by adhering to the fingers, if they are dry. Winslow therefore advised that some unctuous substance should be rubbed on the hands, before they were applied to it.

The appearance of the great omentum is very different in

different persons. In the emaciated, it appears like a delicate transparent membrane: in the corpulent, it is like a broad mass of adeps, which sometimes is very thick. When it is thus loaded with adeps, it is most commonly spread over the small intestines: when it is free from fat, it is often compressed together, so as to form a small mass near the arch of the colon, on the left side.

The principal blood-vessels of the omentum are derived from those of the stomach, and are called gastro epiploic arteries and veins.

The use of this membrane in the animal economy has not been ascertained with certainty. It seems probable that one of its principal objects is to protect the small intestines, and lessen the friction consequent upon their motion; but it has been supposed to answer several other important purposes.*

General Anatomy of Mucous Membranes.

—The mucous membranes form the same sort of lining or tegumentary covering to all the cavities of the body that the skin does to the exterior; and the two are continued insensibly into one another at the orifices by which these cavities open upon the surface. Hence the two are frequently spoken of as the *internal* and *external tegumentary systems*. The first general and satisfactory account of the mucous membranes we owe to Bichat. He divided the whole class of mucous membranes into two great divisions, the *gastro-pulmonary*, and the *genito-urinary*. The gastro-pulmonary commences from the mouth, nose, and eyes through the lachrymal passages, covers the nasal, buccal and pharyngeal cavities, and is prolonged into the salivary ducts, the Eustachian tube, the aerial passages and the whole length of the alimentary canal, as well as the various secretory ducts which open into the latter.

—The genito-urinary lines the urethra, bladder, ureters, (and pelvis of the kidneys in both sexes,) as well as the vagina, uterus, and Fallopian tubes of the female, where it opens through the peritoneum into the cavity of the abdomen. In the male it is

* See Halleri Elementa Physiologiæ, vol. vi. page 381; Cavard. Traité de Splanchnologie, page 350; and Dr. James Rush's Inquiry into the use of the Omentum.

prolonged from the bladder into the ducts of the prostate, the vesicula seminales, and the vas deferens, to the termination of the last in the seminiferous ducts of the testicle. Beneath the mucous membrane is a layer of cellular tissue, formerly called nervous, which is never seen to contain any adipose matter, and is rarely infiltrated with serum. This connects the membrane in general to a muscular plane below, as in the alimentary canal; sometimes to an elastic tissue as in many of the excretory ducts; and occasionally to the periosteum, as in the nasal cavities. The mucous membrane is in general soft and spongy in its character; an appearance which the skin itself presents in many of the inferior animals and in very young fœtuses. It presents many varieties, in different parts of the body. It will be found to diminish successively in thickness as we examine it in the following order; in the gums, the palate, nasal cavities, stomach, small and large intestines, gall-bladder, urinary bladder, sinuses of the head, and in the excretory ducts: in the last its tenuity becomes extreme. The epithelium, or cuticle which is extended upon this membrane from the skin covering the lips, terminates at the cardiac orifice of the stomach; that which passes in at the anus and vulva, terminates upon the sphincter muscle and the lips of the womb. Every where else, the mucous membranes are covered with a coating or varnish of mucous matter, which resembles the epithelium in its chemical composition, and seems to be even susceptible of being converted into it, when dried and hardened by exposure to the air, as has been observed in cases of artificial anus. They vary in different parts in regard to colour from white to red, passing through all the intermediate shades. They are red near their points of communication with the skin; as in the pharynx and rectum; of a pearl or pale rose hue in the stomach; and almost colourless in the centre of the intestinal canal, except in cases where they have been coloured by disease or by the capillary injection which follows asphyxia.

—The mucous membranes, are thrown in many places into a number of loose folds, which amplify very considerably the extent of its surface. These folds may be seen in the nasal cavities, in the hollow organs in their undistended state, as the stomach

and bladder, but particularly in the small intestines, where they form an extensive series of permanent folds called the *valvulæ conniventes*, or *valves of Kerkringius.*

—The surface of the membrane presents in many places, a superficial honey-comb-like appearance, which is discernible only after close investigation in the stomach and gall-bladder in man, but is strikingly developed in the alimentary canal of our domestic animals, and in many fishes.

—All that is known in regard to the chemical analysis of mucous membranes, is, that they are insoluble in water, even by boiling, but are easy of solution in acids, with which they form a pulp.

—These membranes, though possessed every where of many characteristics common to the whole, vary somewhat in different parts of the body, especially in regard to their villi and their follicles.

Of the Villi.

—On the free surface of the mucous membranes are found a great number of papillary projections called *villi.* (See Fig. 48, page 72.) Each villus is formed of a bundle, which consists at least of one artery, vein, nerve and absorbent, woven together by cellular tissue and covered in by a thinly expanded fold of the mucous membrane. The villi on the tongue, instead of a mucous layer, are covered by the epidermis, (*periglottis*,) which is so thick in many quadrupeds, as to constitute a hard corneous covering, and convert them into instruments of prehension. In the pharynx and œsophagus they hold a sort of middle station between those of the tongue and those of the stomach. The villi of the mucous membrane of the stomach and small intestines, are so particularly numerous and so large, compared with those of the large intestines, bladder and lungs, that Gendrin has proposed to call it by distinction the *villous membrane.*

—If we examine, by the aid of a strong glass, the mucous membrane of the stomach under water, exposed to the strong light of the sun, we perceive the whole surface covered by irregular and very superficial nipple-like projections and marked by shallow grooves passing over the surface of the membrane, so as to give

it the appearance somewhat of the intestinal convolutions. These nipple-like projections are covered by papillæ or villi, and between them are seen the honey-comb depressions which were described by Sir E. Home.* When we examine an oblique or perpendicular cut of the membrane under a simple microscope, we observe thousands of these villi projecting up from the surface of the membrane, like the pile of velvet, so as to form a sort of fleece. The honey-comb depression between these villi, according to the observations of Dr. Boehm,† and Dr. Sprott Boyd,‡ are composed of many tubular follicles, placed perpendicularly in the membrane, and which open into the surface of the cell. The diameter of these cells, according to Dr. Boyd, varied from the $\frac{1}{100}$th to the $\frac{1}{300}$th part of an inch. The bases of these follicles rest upon the cellular coat of the stomach, and are considered by Dr. Boehm, as similar to the tubular follicles of the large intestines. (See Fig. 47, page 69.)

—The villi or papillæ of the mucous membranes are much more fully developed in the small intestines than in any other part of the alimentary canal, with the exception of those upon the tongue. They were first discovered by Fallopius. They occupy the whole length of the small intestines; studding the valvulæ conniven-

* Sir E. Home described these honey-comb depressions as existing only in the left extremity of the stomach, and considered the remaining portion of the stomach occupied by the villi. Careful inspection, as Cruveilhier has observed, will show, that the whole surface of the membrane is constructed alike in this respect, with the exception, that the nipple-like or mammelonnated projections, are more fully developed on the side of the pylorus, than at the cardiac extremity of the stomach. A good idea of the appearance of the villi of the stomach when examined by the microscope, may be formed from an inspection of the papillæ villosæ of the tongue, between the bases of which we are to consider placed the honey-comb depressions.

Ruysh has divided the villous prominences of the gastric mucous membrane into two classes, *papillæ* and *villi*, in which he has been followed by some anatomists: hence the gastric mucous membrane has been called the *villoso-papillary*. But this distinction does not appear to be well founded. Careful observation with the microscope, does not enable us to perceive any difference between them, and they may be called indifferently, villi or papillæ, and considered as the representatives in the mucous membranes of the papillæ of the skin.—P.

† De Gland. Intes. Struct. Penit. Berol, 1835.—P.

‡ Essay on the structure of the mucous membrane of the stomach. Edinburgh, 1836.—P.

tes, as well as the spaces between them. Their number is very considerable: Lieberkühn estimated them at 500,000. Some of the German anatomists, have more recently made a higher estimate of their number than this. They *assert* that there are 4000 to be seen upon every square inch of surface, and which by their calculation would make a million of villi to the small intestines.

—Those of the jejunum, according to the measurements of Dr. Horner, are the thirtieth of an inch in length, and those of the ileum the sixtieth. In the pyloric half of the stomach and in the duodenum, according to Beclard, they are formed of a fold of the mucous membrane, the transverse diameter of which exceeds the length, and which has a tufted arangement. In the jejunum they consist of longer folds, forming semi-oval plates touching one another at their basis. In the ileum, according to Dr. Horner, they form slightly conical projections.

—The villi can be studied to the best advantage after a minute injection of the vessels of the mucous membranes, which by rendering the vessels of the villi turgid, throws them into a state of erection, like that which takes place in the papillæ of the skin when they are in a state of functional activity. The peculiar developement of the villi of the small intestines which will be subsequently considered,* is attended probably by a peculiarity of organization, apparently for the purpose of fitting them for a function which they alone possess; that of chylous absorption.

—In the other mucous membranes, the presence of the villi are by no means so obvious, though they may be detected by the microscope.

The Vessels and Nerves of Mucous Membranes.

—In the submucous cellular or nervous tissue, are found the larger branches of the arteries, veins, and nerves, whose final ramifications take place in the mucous membranes and their villous productions. The vessels are derived from contiguous trunks. The veins are far more numerous than the arteries, and seem to exceed here the large proportion which they bear to the

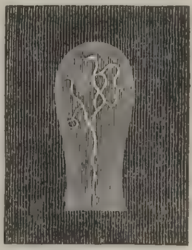
* See General Anatomy of Absorbent System.—P.

veins in other portions of the body. They form, as shown by the elegant preparations of Professor Horner, a plexus on the surface of the membrane, which overlays the arteries, and in which, when successfully injected, a straggling arterial branch is only here and there visible. Beneath this plexus, however, and mixed up with larger veins which anastomose with the superficial venous plexus, the arteries ramify to a great degree of minuteness.

Of the Absorbent Vessels.

—The lacteals of the small intestines arise partly from the villi, and partly from the surface of the intervillous mucous membrane. Nearly all the best recent microscopical observers now agree, that there are no orifices of the lacteals visible in the villi of the intestines. The villi are short processes, a quarter of a line, or at most a line and two-thirds in length, which project above the surface of the mucous membrane and give it, when magnified, the appearance of a thick fleece. Their form is various, cylindrical, pyramidal or lamellated. In most of our domestic animals, they are generally flattened, broad at the base, which runs off into a fold of the mucous membrane, so that many of the villi appear only as a modification of the rugæ or folds of the membrane. The villi are formed exteriorly by a coating of mucous membrane, filled within by a net-work of minute blood-vessels, which can only be well demonstrated by injection, and in which the lacteals take their origin by branches anastomosing in the form of net-work. Fig. 45, is a magnified representation of a villus, seen by Krause, of Hanover, in the jejunum of a young man, who had been executed shortly after eating, and in which the lacteals were filled with chyle. The mucous membrane between the villi, when examined with a single microscope, presents an extraordinary number of small orifices, which are the openings of Lieberkühn's follicles. See Figs. 47 and 50.

Fig. 45.

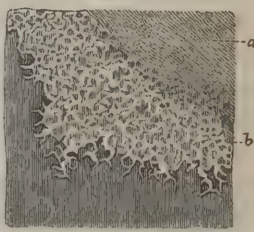


—Fohman, in his most perfect mercurial injection of the lacteals

of the intestine in fishes, and Schwann, in the injection of the lacteals in the intestinal villi in man, found no mercury whatever to escape into the cavity of the intestine. Hence it may be inferred, either that there are no open orifices by which they communicate with the cavity of the intestine, or that they are so exceedingly minute, that no one has yet been able to discover them with the microscope. The origin of the lacteals in the villi, is, in all probability, the same as that of absorbents in other parts of the body, by a net-work of extreme minuteness.*

—Fig. 46, is a representation of the origin of the absorbents from the mucous membrane of the stomach, in the form of a net-work, as they appeared to Breschet.

Fig. 46.†



—The very presence of the intestinal villi, found in man and the superior animals, is not indispensable to chylous absorption, for, in a large number of animals, the internal surface of the small intestines is destitute of villi.

Of the Nerves.

—The nerves of these membranes, are derived in many parts, as the intestines, biliary ducts, etc., mainly from the sympathetic nervous system; hence such parts are necessarily devoid of animal sensibility. In the stomach, upper part of duodenum, œsophagus, mouth, lungs, and rectum, it receives branches likewise from the cerebro-spinal system, which places it in those parts, partly in the dominion of the animal functions.

Of the Blennogenous or Muciferous Glands.

—These exist in great numbers in all mucous membranes, and are the source of the mucous substance, which covers the surface of the membrane.

* This is a doctrine long since advocated by Hewson.—P.

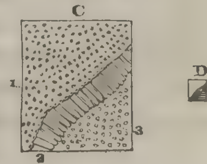
† *a*, A layer of superficial absorbents. *b*, A layer more deep seated.—P.

—The anatomy of these organs, has heretofore been involved in a considerable degree of confusion, and though it is not yet satisfactorily established, enough has been done to enable us to make a division of them into classes, so as to render the description of them more intelligible.

—From the researches of recent observers, they may be divided into two classes. The *first*, comprising the mucous follicles or mucous cryptæ, and mucous glands. The *second* class is composed of some vesicular bodies, which may be subdivided into, 1st, The glandulæ solitariæ, (*glands of Brunner, of some anatomists,*) and 2d, The so called glandulæ agminatæ, or glands of Peyer. The two first are generally spread throughout the mucous membranes, and seem to differ from each other but little, except in regard to the degree of their developement. The mucous follicles are entirely microscopical; and were first particularly described by Lieberkühn in the small intestines, where they are frequently called the follicles of Lieberkühn.

—If a portion of the mucous membrane of a small intestine be well washed, we may readily discover, by means of a simple microscope, around the basis of the villi an extraordinary number of orifices not visible to the naked eye, which are the opening of Lieberkühn's follicles; these openings are about eight or ten times as large in diameter, as the red particles of the blood.* Sometimes these openings are so close and numerous, that the space between the orifices is scarcely so broad as the orifices themselves; generally, however, they are more widely separated, in which case they give a spongy appearance to the membrane. These follicles of the small intestines, which were observed by Lieberkühn, appears to be the exact counterpart of the tubular follicles observed in the whole extent of the mucous membrane of the large intestine by Dr. Boehm, and in the mucous membrane of the stomach by Dr. Boyd. C, Is an enlarged view of the tubular follicles of the large intestine, as they appear-

Fig. 47.



* Muller's Physiology, p. 260.—P.

ed to Dr. Boehm. D, Is the natural size of the piece magnified. They are arranged side by side perpendicularly in the membrane, their closed or cæcal bases resting upon the subjacent cellular tunic of the intestines, as seen at 2, which represents a perpendicular cut through the mucous membrane, down to the cellular coat. 3, Is the surface of the cellular coat, from which the mucous membrane has been removed, showing the pits or depressions in which the basis of the follicles are lodged. 1, Is the free surface of the mucous membrane, showing the openings of the follicles which are believed to be the same as the orifices of Lieberkühn.

—In the stomach, the cryptæ alone are said to exist, except at the curvatures, where a few of Brunner's glands are met with; yet in a child dead from summer cholera, the follicles were so enlarged or hypertrophied that I could distinctly count with the naked eye, in a square inch on the sides of the stomach near the pylorus, a hundred and twenty-five opaque bodies below the membrane, which presented all the usual characteristics of the glands of Brunner in the small intestines. In the same subject, the glands of Brunner,* (*duodenal and mucous glands*,) were much enlarged; and in the same extent of surface, I counted without a glass, a hundred and seventeen in the duodenum, ninety-five in the upper portion of the jejunum, and thirty-five at the commencement of the ileum.

—Dr. Horner,† who is justly distinguished as an anatomical discoverer, has made, with the assistance of Dr. Goddard, the size and number of these follicles, the subject of attentive microscopical examination. He has found them to vary in size in the stomach from the $\frac{1}{98}$th to the $\frac{1}{490}$th part of an inch in diameter, and in the colon from the $\frac{1}{245}$th to the $\frac{1}{490}$th. He estimates the whole number of follicles in the *stomach* and *intestines*, at *forty-six millions, nine hundred thousand, and upwards.* Of these there belong to the stomach, *one million, two hundred and ninety-six thousand;* to the small intestines, *thirty-six millions*, and to the colon, *nine millions, six hundred and twenty thousand.* And to

* De Structura Glandulorum Intestinorum. Berl. 1836.—P.

† Special and General Anatomy, vol. 2, p. 40, fourth edition.—P.

the inch square, in the stomach, *fourteen thousand, four hundred*, in the small intestines, *twenty-five thousand*, and in the colon, *nineteen thousand, two hundred*.*

—The mucous glands, compared with the follicles or cryptæ, are generally of considerable size, and visible to the naked eye; and in fact appear only to be compound cryptæ. They are little bodies placed in the submucous cellular tissue, appearing slightly lobulated when examined with the microscope, and containing minute cells, lined by a reflection of the mucous membrane. These are found most abundant in parts of the mucous membrane, where, from its exposure to acrid or irritating substances, the membrane would appear to need the most protection from the mucous coating; as in the mouth, the duodenum and the rectum.

—These glands have already been described in the trachea and bronchia, etc. They bear names in many places according to their location, as labial, buccal, palatal, œsophageal, and duodenal. In the duodenum, of all places, they are most abundant where the acrid and irritating biliary secretion first comes in contact with the mucous membrane of the alimentary canal. To these only properly belong the term of *glands of Brunner*, for to these his description was mainly applied.

—Brunner was the first to describe in the mucous membrane of the duodenum, a series of flattened glandular granulations, studding thickly the upper half or two-thirds of this membrane, and which he considered analogous in structure to the granular acini of the pancreas.

—He considered them also similar in structure to the solitary glands; but in this respect he has been proved to be in error. Cruveilhier has observed the analogy of these glands, not only with the acini of the pancreas, but with those of the different salivary glands. These glands he found to diminish gradually in number, towards the lower end of the duodenum, so that none was to be observed farther down than the commencement of the jejunum. Dr. Boehm has verified these observations of Cruveilhier, and shown that they are little solid glands, formed of several

* Lalut has estimated the follicles of the small intestines at 40,000.—P.

minute lobules, each of which is found to be cellular; and that all the cells of each gland open by a common orifice.

—The third and fourth order of glands, the *glandulæ solitariæ*, and the *glandulæ agminatæ*, are met with only in the alimentary canal. The latter are found almost entirely in the lower half of the small intestines, and it has been rendered questionable by the researches of Boehm and Müller, whether solitary glands of the small intestines do not differ from those met with in the stomach and large intestines.

—The solitary glands are found at the end of the small intestine, in the large intestine, and a few along the lesser curvature of the stomach. They present the appearance of small granulations of the size of millet seed, and which project slightly on the internal surface of the mucous membrane. Neither Boehm, nor Müller, who has verified all Boehm's researches by his own use of the microscope, have been able to discover in the undiseased state,

Fig. 48.

any opening of the solitary glands of the small intestine. But when ulcerated in tubercular affections, or in dothinenteritis, the cavity is exposed. Fig. 48, is a magnified representation of one of the solitary follicles or sacculi of the small intestines after Boehm. It has no apparent orifice; it is studded with villi, and round it are seen the orifices of Lieberkühn's follicles.

—In the large intestines, the orifices of these follicles are readily

Fig. 49.

discovered. B, is a representation of one of the solitary follicles of the large intestine, by the same author, in which the orifice may be discovered in the centre, with many of the openings of Lieberkühn's follicles around it. A, is a vertical section of the same follicle, showing its cavity and the orifice by which it communicates with the interior of the large intestine. Around it are seen the vertical tubular follicles of Boehm, which appear to be synonymous with the follicles of Lieberkühn.

The Glandulæ Agminatæ,

—Are better known under the name of *glands of Peyer*, after a young anatomist who described them, as well as the solitary glands with much minuteness,* though they had previously been pointed out by Pechlin, under the name of *Vesicularum Agmina.* —These so called agminated follicles, present themselves as patches under a variety of forms, generally elliptical, but sometimes circular or oblong. The longest diameter of the patches when they are either elliptical or oblong, is always parallel with the axis of the intestines. The patches are met with of all sizes from two or three inches in their longest diameter, to a few lines only. They vary also in regard to number; sometimes fifteen or twenty only, are met with in one subject, and sometimes thirty or more.

—In all cases they are found placed in the mucous membrane, on the side over against the insertion of the mesentery. They are found only in the small intestines, and usually in the lower half, and are most numerous near the termination of the small intestines in the colon. Peyer, however, asserts, that he discovered in one instance a patch in the duodenum. These patches appear to be formed of an agglomeration of entirely distinct bodies, exactly analogous to the solitary glands of the small intestines; and in some cases where the number or size of these agminated glands of Peyer is less than usual, the number of the solitary glands in the same region of intestine, appears to be increased.

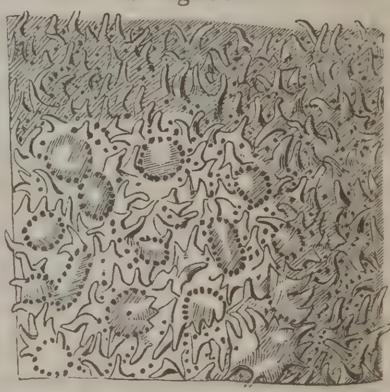
—The appearance which these glands of Peyer present, is, however, in other respects very variable. Sometimes in perfectly healthy intestines, they can scarcely if at all be distinguished; and when seen, generally appear, if held up between the observer and the light, as little vesicles like those in the rind of an orange, and in which no orifice can be seen even with the glass. In tubercular disease, and especially in typhoid fever with affection of the bowels, (dothinenteritis,) they are usually found enlarged, and ulcerated so as to expose an abrupt cellular cavity.

* De Glandulis Intestinorum. J. Conradus Peyer, 1667.—P.

The structure of these solitary and agminated glands, so different from that of the other follicles of mucous membranes, has lately attracted considerable attention, and the researches of Boehm* and Müller† have rendered it doubtful, whether they really belong to the class of follicles or not.

—Fig. 50, is part of a patch of Peyer's glands greatly magnified, (after Boehm.) Here the follicles of Peyer are seen as circular white spots, about a line in diameter, with no apparent orifice, and surrounded with a circular zone of foramina, which belong, as well as those scattered between the glands, to Lieberkühn's follicles. Dr. Boehm tried in vain to express any secretion from the white bodies through an external opening, as he probably could have done, had they been follicles; nor was he more successful in endeavouring to force it through the orifices forming the zone. On rupturing one of the bodies, a cavity was opened similar in extent to the white body itself, in which was found a grayish white mucous matter, composed of particles smaller than the ordinary particles of mucus. According then to Boehm and Müller, there are not, in the healthy state, in the patches of the so called Peyer's glands, any large follicles with open mouth or cells, but merely sacculi, of which the nature is unknown.

Fig. 50.



—Fig. 48, p. 72, is a representation after Boehm, of one of the solitary glands of the small intestines, which have been confounded with the glands of Brunner, and which is precisely similar in structure and appearance, to one of the bodies in the patches of Peyer, with the exception that its surface is more thickly studded with villi.—

* Loc. cit.—P.

† De Glandularum Secernent. Structura penitiora, etc. Leipsic, 1830.—P.

General Anatomy of the Glandular Tissue.

Any *original* structure that discharges from the blood-vessels a fluid different from those which they naturally contain, may be considered as glandular. The function or process by which such fluids are derived from the blood-vessels is called *secretion.*

A structure of this kind seems to exist in very different situations: for it is distinctly circumscribed in many of those bodies commonly denominated glands, which are of a very precise form; and it is also diffused on some very extensive surfaces. The gastric liquor, a most important secretion, is probably discharged from vessels which open, like exhalents, on the internal surface of the stomach, and not from any circumscribed bodies, which are generally denominated *Glands.*

The name of gland is theoretically applied to several bodies which cannot be proved to secrete any fluid whatever; and also to those bodies connected with the absorbent vessels, which are called the *Lymphatic Glands;* but it is most commonly appropriated to those organs which *discharge* a fluid different from the blood.

The structure by which mucus is secreted in some places, appears to be very simple. Thus, in the Schneiderian membrane and the urethra, there are small ducts from four to six lines in length, and equal in diameter to a bristle, which appear to be formed of the membrane on which they open. From these ducts mucus issues to cover the surface of these membranes. In many instances there is no substance resembling that of the circumscribed glandular bodies, connected with these ducts; but the secreted fluid seems to be discharged into the ducts from the small vessels on their surfaces. The ducts of this nature in the urethra are denominated *Lacunæ.*

In some other parts of the body, the cavities into which mucus is discharged are somewhat different, both in form and size, from those above mentioned, and are called *Follicles.* These cavities are surrounded with more or less of a pulpy vascular substance, which has been considered as glandular, and essential to the mucous secretion.

The circumscribed bodies, which are commonly called glands, differ in their internal appearance and texture, from the other parts of animals. The substance of which they consist differs very much in the different glands; and thus renders the liver, kidneys, salivary glands, mammæ, &c., very different from each other. Some glands, as the salivary, &c., are composed of several series of lobuli that successively diminish. The smallest of these are denominated *Acini.* Each of them is connected by a small artery and vein, to the large blood-vessels of the glands; and also sends a branch to join the excretory duct.

These *Acini* are therefore connected to each other, by the blood-vessels and excretory duct of the gland, and also by the cellular membrane which covers them externally, and occasions them to adhere to each other where they are in contact. In consequence of this structure, these glands have a granulated appearance.

The liver, when incised with a sharp instrument, appears differently; but when broken into pieces, it seems to consist of small acini. Some other glands, as the *Prostate,* appear to be uniform in their texture, and have none of this granulated appearance.

The structure of glands has long been an interesting object of anatomical inquiry, and was investigated with great assiduity by those eminent anatomists, Malpighi and Ruysch.

Malpighi, as was formerly observed, used ink and other coloured fluids in his injections. He was also very skilful in the use of microscopes, and took great pains in macerating and preparing the subjects of his inquiries. Ruysch, on the other hand, used a ceraceous injection, and was most eminently successful in filling very small vessels with it. Malpighi believed that there were follicles or cavities in glandular bodies, which existed between the extremities of the arteries and the commencement of the excretory ducts of those bodies, and that in these cavities the secreted fluids underwent a change.—Ruysch contended, that the arteries of glands were continued into excretory ducts, without the intervention of any cavity or follicle; that the small bodies which had been supposed to contain follicles

or cryptæ, were formed by convolutions of vessels, and that the change of the fluid, or the process of secretion, is produced by the minute ramifications of the artery.

A very interesting account of this subject is contained in two celebrated letters, which passed between Boerhaave and Ruysch in the year 1721, and are published at the end of the fourth volume of the works of Ruysch.

The opinion of Ruysch has been more generally adopted by anatomists, and has derived support and confirmation from several anatomists since his time. The late Mr. Hewson declared his conviction that the small globular bodies which are scattered through the kidneys, and were supposed to be follicles or cryptæ, are merely convoluted arteries. He also asserted, that the acini which appeared in the mammæ as large as the heads of pins, when the excretory ducts of that gland were injected with vermilion and painters' size, proved to be the minute ramifications of the excretory duct, which divided very suddenly into branches so small that they could not readily be seen by the naked eye.*

Notwithstanding these reasons for supposing that the excretory ducts of glands were derived simply from the arteries of those bodies, it is said that the late Dr. W. Hunter used to declare his belief, that there was a part in glands which was not injected in his preparations; and to say farther, that he believed his preparations were injected as minutely as those of Ruysch.

All of these opinions have been strenuously controverted by the Italian anatomist, Mascagni, who believes that the arteries terminate only in veins; and of course that they neither form exhalent vessels, nor communicate with the excretory ducts of glands. His idea of the structure of glands is different from those either of Malpighi or of Ruysch.

He supposes that glands contain a great number of minute cells; that the arteries, veins, and absorbent vessels are spread upon the surfaces of these cells, in great numbers, and very irregularly. From these cells very small canals originate, which unite to form the small branches of the excretory ducts. Ac-

* See Experimental Inquiries, vol. ii. p. 178.

cording to his idea, the secreted fluid is discharged through pores or orifices of the blood-vessels, into the cells, and proceeds from them through the canals, into the branches of the excretory ducts. Absorbent vessels, in great numbers, originate from these cells.

In his great work on the absorbent system, when treating on the termination of arteries and the commencement of veins, (Part I, Section 2,) he asserts, that if the kidneys are successfully injected with size, coloured with vermilion, and then laid open by a section of a razor, it will be found that the size without the colour has passed into cells which are very numerous; that the arteries and veins are ramified most minutely on the surfaces of these cells, and that the tubuli uriniferi, as well as the absorbent vessels, originate from them.

He supposes that a considerable portion of the fluid thus passing off from the blood-vessels, is commonly taken up by the absorbent vessels of the kidneys: for in two cases in which he found the absorbent vessels obstructed, a diabetis existed, which he considered as the effect of the inactivity of the absorbents. He asserts, that in the liver, pancreas, mammæ, and also in the salivary and lachrymal glands, the minute arteries and veins are also distributed upon the surfaces of cells; and that very small canals arise from these cells, and unite to form the small branches of the excretory ducts.

This great anatomist appears to have been much occupied with microscopical observations, and has gone largely into the discussion of this subject.*

—The opinions of the distinguished anatomists which have been detailed above, conflict, as has been seen, considerably with each other. They were, however, legitimate deductions from their own experiments and observations, and each entitled to credit, since every one of these great men has added considerably to the knowledge of this interesting and intricate

* The late Dr. W. Hunter, in his Medical Commentaries, (p. 40,) avowed his belief, that the fluids which appear occasionally in the various cavities of the body, transude through the coats of the blood-vessels. Mr. Hewson, (Experimental Inquiries, Vol. II. Chap. 7,) suggested several reasons for dissenting from this opinion; but Mascagni has endeavoured to support it.—See a long note to the above mentioned section of this work, page 74.

department of general anatomy. Since then, other observers have contributed much to the elucidation of the structure of different glands, of whom we shall hereafter have occasion to speak; and lastly, Müller has published a work, *ex professo*,* upon the subject, which has reconciled many of these conflicting opinions. This observer has extended his investigation into the comparative anatomy of all the glands, and to their developement at the different stages of fœtal life, and having a full acquaintance with all that had been previously discovered, his researches may be looked upon as classical upon this subject.

—Of all the various opinions entertained, that of Malpighi according to Müller, was nearest the truth; viz., that the elementary parts of all glands, the so named *acini* or *granules*, have the same structure as the simple and compound follicles or follicular glands, each one consisting of minute, roundish sacs, which receives its secretion from the blood-vessels distributed on its walls, and which secretion is poured into the efferent duct. But these cavities, which Malpighi believed to be single elementary follicles, and Mascagni and Cruikshank simple cells, have been shown by Müller, to consist of an aggregate of many minute ramifications of the duct, which terminate by closed or cæcal pouches, as is seen in Fig. 51, upon which the vessels ramify, and which constitute the real elementary parts of the gland.

Fig. 51.†

—The individual forms, which these minute ramifications of the secretory ducts assume, vary, however, somewhat in the different glands, though they are alike in the general result; that of forming an independent system of tubes, ramifying so as to gain a great extent of surface for their lining membrane. The finest secreting tubes, which are closed at their extremities like the follicles of the simple mucous membranes, are never, how-

* De Glandularum Secernentium Structura Penitiore, earumque prima formatione, etc. Leips. 1830.—P.

† This is a magnified representation after Weber, of a portion of a parotid gland. The smaller figure is the natural size of the piece magnified. *a*, The cells clustered on the extreme branches of the duct of Steno.—P.

ever, as has been proved by microscopical measurement, so minute as the compound follicle, in which there is a single duct common to several exceedingly minute follicles of the simple kind; which seem to be formed by the amplification of the surface of a simple follicle, depressed on its sides into a number of cellular dilatations which open through the common duct. Specimens of these, are to be found in the Meibomian glands, the tonsil, labial, buccal, duodenal glands, etc.

—In other *more complicated* glands, is found a further developement of the *follicular sac*, and the *excretory tube*. In these *compound* or *conglomerate* glands, such as the lachrymal, mammary, salivary glands, pancreas, liver, etc., the excretory tube is longer and ramifies in the manner of a tree. In some, the tubes ramify with a certain degree of regularity, as in the mammary gland, represented in the following figure.

Fig. 52.*

—The divisions given off by the main duct of the gland divide again by giving off side branches; these divide and subdivide in like manner in their turn, till finally, a subordinate branch of minute size terminates in a cluster of blind pouches or follicles, which are invested on their outer face by cellular tissue, and capillary vessels, and form one of the acini or granules of a gland. A

* The diameter of the cells or terminal cavities of the lactiferous ducts, is large, compared with those of many other glands; it is from ten to thirty-five times greater, according to Müller, than that of the smallest capillary vessels in the human body.—P.

collection of these *acini*, which correspond to a particular division of the excretory duct, will necessarily be a little separated from other parts of the gland, and is called a lobule. This is the arrangement in all the lobulated glands, viz. the lachrymal, mammary, salivary glands, and the pancreas. Each acinus is not therefore, as was supposed by Malpighi, Ruysch, and Mascagni, a single cell, but a cluster of cells, too minute to be seen, except in the distended state and by the aid of the microscope, seated upon the extremity of a minute branch of the excretory tube, and surrounded by a net-work of capillaries, exactly analogous in structure to one of the mucous glands of the mouth, or of the duodenum. Sometimes, instead of the short cells of the acini, the ducts terminate in long excretory tubes, as in the kidney and testis, when the length of the tube compensates in regard to the extent of secretory surface, for the nondivision into cells.

—In some glands, as in the liver of man and all the vertebrate animals, and in the kidneys of oviparous animals, where there is a portal circulation, and the secretion is made from venous blood, the arrangement is somewhat peculiar. The ducts ramify irregularly, present no arborescent arrangement, and there is no distinct division into separate lobules. The excretory ducts terminate in the acini, in the form of tufts of microscopical tubes, which anastomose together so as to form a sort of net-work in the body of the acinus: the centre of each acinus, in these peculiarly constructed glands, being occupied by a vein, according to Kiernan,* which carries away the blood of the portal system, after its excrementitious parts have, by the secretory action, been transferred to the branches of the excretory duct.

Capillary Blood-Vessels.

—Those of the liver and kidneys are considered the most minute; yet these have a diameter two or three times as large as the minute arteries and veins, which may be seen with the microscope, ramifying on the ducts and forming a capillary net-work on their walls and interstices, and from which the fluids are distilled into the cavities of the tubes, modified in different parts, so as to constitute the peculiar secretions. Thus, in the kidney and

* See Anatomy of Liver.—P.

testis, the ducts are arranged in convolutions and terminate abruptly in a *cul de sac;* in the pancreas, salivary and mammary glands, etc. they have an arborescent arrangement, and terminate in grape-like clusters of cells; the general fact of the distribution of these vessels upon their walls, and the mode in which secretion is effected being much the same in all. There is no inosculation or direct termination of a blood-vessel in a duct as Ruysch supposed, and the experiments that have given rise to this opinion, that of passing a fluid by forcible injection from a secretory duct into a blood-vessel, or *vice versa,* have been attended by a rupture of the fragile structure of the glands, by which the injection has mechanically insinuated itself from one system of vessels into the other.

—The simplest form of gland, is that of a mere depression or recess in the surface of a membrane, as the sebaceous follicles of the skin or cryptæ or follicles of the mucous membrane. These have but a simple orifice, or a short duct. The next degree, of complication in the structure of glands, is that of the cellulated or compound follicle, and its highest degree of developement is met with in the conglomerate glands, as the parotid, the mammary, and the liver.

Microscopical Measurement of the Diameter of the Capillary Vessels, and Ultimate Divisions of the Excretory Tubes in some of the Glands.

	Parts of an Inch.
Capillary blood-vessels, according to Weber,	$\frac{1}{3700}$ to $\frac{1}{1900}$
" " in the kidneys, " Müller,	$\frac{1}{2490}$ to $\frac{1}{1590}$
The smallest pulmonary air-cells in the human subject (Weber,) which have a termination somewhat like the ducts of glands, - -	$\frac{1}{999}$ to $\frac{1}{69}$
Tubuli uriniferi in the cortical substance of the human kidney, (Weber,) - - -	$\frac{1}{512}$
" " in the pyramidal portion, -	$\frac{1}{577}$
" " in the papillæ, - -	$\frac{1}{923}$
Tubuli seminiferi of man, (Müller,) - -	$\frac{1}{195}$
" " distended with mercury, -	$\frac{1}{97}$
Tubuli recti testis, (Lauth,) (undistended,) -	$\frac{1}{99}$
Cells of the Meibomian glands, (Weber,) -	$\frac{1}{356}$ to $\frac{1}{145}$

It must, however, be acknowledged, that no information which has as yet been obtained respecting the structure of glands, enables us to explain their wonderful effect upon the fluids which pass through them. It remains yet to be ascertained why one structure forms saliva and another bile; or why so much apparatus should be necessary for the secretion of milk when adipose matter appears to be produced by the mere membrane in which it is contained.

Dr. Berzelius, professor of Chemistry at Stockholm, in a late work on animal chemistry, asserts, that if all the nerves going to a secretory organ are divided, secretion will cease, notwithstanding the continued circulation of the blood. From this, he thinks, that secretions depend upon the influence of nerves, although he cannot explain their effects.

Mr. Home, after relating some experiments upon blood and serum, made with the Voltaic Battery, proposes the following questions, among others: Whether a weaker power of electricity than any which can be kept up by art, may be capable of separating from the blood the different parts of which it is composed; and forming new combinations of the parts so separated? Whether the structure of the nerves may enable them to possess a low electrical power, which can be employed for that purpose? &c.

See the London Philosophical Transactions, for 1809, part II.*

* Mr. Wollaston has also published a small paper on this subject, in the Philosophical Magazine, vol. 33.

CHAPTER III.

OF THE LIVER, THE PANCREAS, AND THE SPLEEN.

Of the Liver.

This largest viscus of the abdomen, when in a healthy condition, is of a reddish brown colour. If it is taken out of the subject, and laid on a flat surface, it is flat, but in the abdomen it is convex and concave.

It is situated in the right hypochondriac region, which it occupies entirely; and extends through the upper portion of the epigastric into the left hypochondriac region. Being placed immediately under the diaphragm, and in close contact with it, as well as with the inner surface of the right hypochondriac region, it partakes of their form, and is convex above and concave below. When thus situated, it is of an irregular figure, between the circular and the oval, but is broader at the right extremity than at the left, and very irregular in thickness. The edge or margin which is in contact with the posterior part of the right hypochondriac region, is very thick. It gradually becomes thinner towards the left, and also towards the front; so that the right margin, and a large portion of the posterior margin, is very thick, while the left and anterior margin is thin.

The upper convex surface of the liver, when in its natural situation is smooth: the lower concave surface is marked by several grooves or fissures and eminences. One of these, called the *Umbilical* or the great fissure, commences at a notch in the anterior edge of the liver, to the left of the middle, and continues to the posterior edge. At the commencement of this fissure the umbilical ligament enters; and at the termination, or near it, the vena cava is situated. Opposite to this fissure, on the upper or convex surface, is a ligament passing from the diaphragm to the

liver, which is called the falciform. The fissure and the ligament divide the liver into its two great lobes, the *Right* and *Left.*

Another great *fissure*, called the *transverse* or *principal*, commences on the right lobe and extends to the left, crossing the first mentioned fissure at right angles, and extending a very short distance beyond it. It is very deep and rather nearer to the posterior than the anterior edge of the liver. In this fissure, near to its right extremity, the great vein, called vena portarum, and the hepatic artery enter, and the excretory duct of the liver, commonly called the hepatic duct, comes out. About the middle of the fissure are two prominences, one on each side; these were called the portæ, or gates of the liver, and hence the great vein was called vena portarum. This vein has two very large rectangular branches, which constitute what is called the sinus of the vena portarum; and they occupy the principal extent of the fissure.

The liver is in close contact with the vena cava behind; and there is either a groove in it for the passage of the vein, or this great vessel is completely enclosed by it. There is also an excavation on the lower surface of the liver, which is occupied by a portion of the gall-bladder.

Besides the great lobes above mentioned, there are also two or three prominent parts, in the concave surface, which are denominated lobes. One of these, called *Lobulus Spigelii*, is oblong, with two sides, and an angle continued along its whole length, which extends from the transverse fissure on the posterior margin of the liver. It is situated between the posterior part of the transverse fissure, or ductus venosus, and the vena cava.

The anterior extremity of this lobe, which forms one of the margins of the transverse fissure, is somewhat bifurcated, and has been called lobulus caudatus. The largest portion of the bifurcated end forms a process like a papilla, and is one of the portæ.

Between the umbilical fissure and the depression for the gall-bladder is a protuberant space, which varies from an inch and a quarter to two inches in breadth. This has also been called a lobe, *Lobulus Quartus* or *Anonymous;* its posterior point, oppo-

site the papilla of the lobulus spigelii forms the other part of the liver.

The peritoneum is extended from the surface of the abdomen to the surface of the liver, in such manner as to cover it, and to form ligaments, which have a great effect in retaining it in its proper situation. The whole posterior edge of the liver is in contact with the back of the abdomen. The peritoneum above the liver is reflected to the upper surface of it, and the peritoneum below it to the lower surface; so that two lamina of the peritoneum pass from the lower part of the diaphragm at the back of the abdomen to the posterior edge of the liver. These processes of the peritoneum are considered as forming two ligaments, which are called the *right* and *left lateral ligaments.* A portion of the posterior surface of the liver, uncovered by the peritoneum, is often in contact with a portion of the tendon of the diaphragm, also uncovered by peritoneum: around this place of contact, the peritoneum is extended from the diaphragm to the liver, and thus forms what has been called the *coronary* ligament of the liver.

The peritoneum of the right side of the diaphragm, and of the abdominal muscles, as far down as the umbilicus, is extended to the liver, and joins it on the convex surface immediately opposite to the umbilical fissure. The peritoneum from the left side of these parts does the same; and as these reflections of the peritoneum are continued from so low a part as the umbilicus, they are extended not only to the convex surface of the liver, but also to the great notch, and along the umbilical fissure.

From the umbilicus proceeds a round cord-like ligament, which in the fœtal state was a vein, that passes to the great fissure of the liver, and along it. The process of the peritoneum above mentioned is so connected with this cord, that it encloses it in its lower edge, and the whole is called the *falciform* ligament of the liver. The cord, when named separately, is the *umbilical* or the *round* ligament; and the membrane or lamina of the peritoneum forms the *suspensory* ligament. Besides these, the peritoneum on the lower side of the liver is so arranged, that

it not only extends to the stomach, but to the duodenum and the colon.

By these ligaments the position of the liver must be fixed to a great degree; and there is one additional connexion, which must have a great effect in retaining it in its proper situation. The vena cava receives two or three great veins from the liver, (*venæ cavæ hepaticæ*,) at the place where it is in contact with the posterior edge of that viscus: these veins of course pass directly from the substance of the liver into the cava, and connect it to that vessel. As the cava is supported by the heart, and also by the diaphragm, it must afford a considerable support to the liver.

When the stomach and intestines are distended, they must also contribute in a considerable degree to the support of the liver.

The liver has a strong tendency, when we are erect, to change its situation; and some considerable support is necessary to counteract this tendency. It would move to the right, when we lie on the right side, if it were not in contact with the ribs: and it inclines to the left, for want of such support, when we lie on the left side.

It has been computed, that the liver descends about two inches, when the position of the subject is changed from the horizontal to the erect. As it is in contact with the diaphragm, it is obvious that it must be influenced by the motions of that muscle, and that it must descend when the diaphragm contracts.

The liver is composed of a substance which has some firmness of consistence, although it is yielding; and is also somewhat brittle or friable.* When cut into, the sections of many tubes, or vessels of different diameters, appear on the cut surface. When the texture of this substance is more closely examined, it appears somewhat granulated, or composed of very small bodies, which were called acini by the anatomist who first described them. The whole substance is enclosed by the peritoneum, which is extended to it from the surface of the abdomen in the manner that has been already described. It has also a proper

* It has been fractured in the living body by external violence.

coat or capsule; and on the posterior edge, where the lamina of the lateral ligaments pass from the diaphragm to the liver, at some distance from each other, a portion of the liver, covered by this coat and by cellular substance, is in contact with the diaphragm. The same thing occurs likewise at the coronary ligament.*

The liver holds the first place among the glands of the body for size, but it is still more remarkable for some other circumstances in its economy. In addition to an artery, which passes to it as arteries do to other glands, there is a large vein, (*vena portarum*,) which also enters it as an artery; and after ramifying throughout the liver, communicates, as does the artery, with other veins, which carry the blood from this gland into the vena cava and the general circulation. There are therefore three species of blood-vessels in the liver; and with these are found the vessels which carry out of the gland the fluid secreted by it, or the bile.

The artery of the liver is denominated the *Hepatic Artery.* The vein which goes to the liver is called the *Vena Portarum*, from the place at which it enters. The veins which carry to the vena cava the blood brought to the liver by the hepatic artery and the vena portarum, are called the *Hepatic Veins;* and the duct through which the bile flows out of the liver, is called the *Hepatic Duct.* Three of these vessels, the *Hepatic Artery*, the *Vena Portarum*, and the *Hepatic Duct*, enter the liver at the great fissure, at the spot where the prominences exist called the portæ; hence the name vena portarum was applied to the vein.

These vessels ramify in the manner presently to be described; and it is ascertained by minute anatomical investigation, that the liver is entirely composed of the ramifications of these vessels and of the hepatic veins, with absorbent vessels and nerves, which are connected together by cellular membrane.

It has been already observed, that the first great branch sent

* Many anatomists deny the existence of this coat; but if one of the lamina of the ligaments be carefully peeled off from the surface of the liver which is slightly affected by putrefaction, it will be apparent, although very thin. It was described by M. Laennec, in Le Journal de Medicine for 1803.

off by the aorta in the abdomen, the *Cœliac*, divides into three branches, which go respectively to the stomach, the liver and the spleen.

The *Hepatic* is generally the largest of these branches. In its progress towards the liver it sends off an artery to the stomach, called the gastrica dextra. At the great fissure it divides into two branches: the right branch, which supplies the right lobe of the liver, is of course the largest. This branch sends off one to the gall-bladder, which is called the cystic artery; and also some smaller branches: it passes under the hepatic duct, and ramifies through the great lobe of the liver. The left branch is distributed through the left lobe of the viscus. It can be proved by injection, that the hepatic artery communicates not only with the hepatic veins, but with the biliary duct, and the vena portarum also. It has been disputed whether the size of this artery is greater than would be requisite for the nourishment and animation of the liver.

The *Vena Portarum*, the great peculiarity of the liver, originates from all the chylopoietic viscera except the liver, and is of course formed by the union of the veins which correspond to all the branches of the cœliac and mesenteric arteries, as they are distributed to the stomach and intestines, the spleen, the pancreas, and the omentum. The veins from the intestines generally form two great trunks, which are denominated the greater and lesser mesenteric veins. The great mesenteric vein is situated to the right, and rather before the mesenteric artery.—After it has approached the origin of the artery, it separates from it, and passes behind the pancreas: at this place, nearly in front of the spine, it is joined by the great vein of the spleen, which forms almost a right angle with it, and these constitute the great trunk of the vena portarum. The lesser mesenteric vein, which corresponds to the inferior mesenteric artery, and brings blood from the pelvis and from the left part of the colon, becomes finally a large vessel, and commonly unites with the splenic about an inch and a half before its junction with the superior mesenteric vein. The vena portarum, thus formed, proceeds towards the liver, inclining to the right, and is generally about three inches in length: in its

course it sometimes receives small veins, which in other cases pass to its splenic and mesenteric branches. When it has arrived at the great transverse sinus of the liver, it divides into two large branches, each of which forms nearly a right angle with it. Their size is so great, that, when distended with injection, they appear like an independent vessel, into which the vena portarum enters; and on this account they are called the *Great Sinus* of the vena portarum. They do not adhere firmly to the glandular substance of the liver, but are united to it by cellular membrane. The right branch is the widest and shortest. It generally divides into three branches; an anterior, a posterior, and a lateral branch; which ramify minutely, and extend themselves in the right lobe. The left branch is much longer, and continues to the extent of the transverse fissure. Near its termination it is joined by the umbilical ligament, which has been already mentioned. This branch is generally in contact with a branch of the hepatic artery, and of the hepatic duct; and ramifies like the right branch, into the contiguous parts of the liver.

The *Hepatic* or excretory duct originates, by very small vessels, from the acini or corpuscles of which the liver is composed, and into which the minute ramifications of the vena portarum and hepatic artery extend. They accompany these vessels, increasing as they increase, although the fluid they contain moves in an opposite direction; and two large branches which they ultimately form are situated at the portæ of the liver, in contact with the great branches of the vena portarum and the hepatic artery.

These three vessels are in contact with each other before they enter the liver. The biliary duct is anterior, the vena portarum posterior, and the artery to the left of them. They are accompanied by nerves and lymphatic vessels, and are surrounded by a considerable quantity of cellular substance, and thus arranged are partially covered with peritoneum. The cellular substance which invests them continues with them into the liver, and is more particularly connected with the vena portarum. It is called *Glisson's Capsule*, and was supposed to have some contractile power, which assisted the circulation of the vena portarum; but that idea is now altogether abandoned. The hepatic veins.

which receive the blood of the hepatic artery and the vena portarum, open into the anterior part of the vena cava, where it is in contact with the liver. Generally there are three of these veins, but sometimes there are only two; in which case one of them is formed by two others, which unite immediately before they open into the vena cava. It is to be observed, that the various branches of these veins do not accompany those branches of the vena portarum or hepatic artery to which they correspond, but form very large angles with them. This is probably owing merely to their termination in a part so distant from that in which the artery and the vena portarum originate; but it is very different from what occurs in other glands.

The *Nerves of the Liver* are derived from the semilunar ganglions of the splanchnic nerves. From these many nerves proceed, which form a net-work denominated the solar plexus. From this plexus many threads are sent off, which form a net-work that is divided into the right and left hepatic plexus. These plexuses surround the hepatic artery and the vena portarum, and accompany them in their ramifications throughout the liver, being enclosed by Glisson's capsule. They receive some threads from the stomachic plexus, formed by the par vagum. Although the number of nervous fibres is very considerable, their bulk, compared with that of the liver, is very small.

The *Lymphatics of the Liver* are extremely numerous; and those in that portion of the peritoneum which invests the liver may easily be rendered conspicuous: for by pressure the injected fluid can be forced from the trunks and large branches into the small ramifications, in opposition to the valves. When all the surface is injected in this manner, it has the colour of the substance injected; as is the case with parts which are very vascular, when the blood-vessels are injected.

The deep-seated lymphatics are also very numerous in the liver, and communicate freely with the superficial.

The superficial lymphatics, which are on the upper surface, proceed through the diaphragm into the thorax in their course to the thoracic duct. Those which are deep-seated emerge from the liver at the portæ, where the great vessels enter, and unite with the thoracic duct in the abdomen, after passing through

several glands. The lymphatics of the lower surface unite with the deep-seated.

The glandular or parenchymatous substance of the liver is of a reddish-brown colour, and moderately firm consistence. When it is cut into, the cut surface exhibits the sections of the branches of the different blood-vessels above mentioned, and of the excretory ducts. These vessels are often distinguishable from each other. The section of the biliary duct appears the thickest; that of the artery next; the vena portarum is next in order; and, last of all, the venæ hepaticæ.

The branches of the vena portarum are surrounded by cellular substance, or Glisson's capsule; and, therefore, adhere less to the substance of the liver than the branches of the hepatic veins. The sections of the hepatic ducts have often bile in them, and are, therefore, termed pori biliarii. The branches of the artery are also very distinguishable.

When the internal substance of the liver is brought into view, and examined accurately, it appears to be formed of small bodies, or acini, which are distinguishable from each other. If the liver happens to be torn or lacerated, the lacerated surfaces are rough and irregular, owing to the separation of these acini from each other.*

It is asserted by several microscopical observers, that a minute branch of each of the aforesaid vessels can be traced into each of the acini. It is also declared, that if each of these vessels be injected separately with mercury, oil of turpentine coloured, or a saturated aqueous solution of gutta gamba, there is no part of the glandular mass as large as a grain of mustard seed in which those vessels will not be found.

Several anatomists of the first character have likewise declared, that a fluid properly injected into one of these vessels, will occasionally pass into all of them. Thus an injection will not only pass from the vena portarum to the biliary duct, but to

* The *acini* are so named from a fancied resemblance to grape or raisin seeds. Between these acini, there is usually a minute quantity of fatty matter, the existence of which is proved by the destructive analysis of the organ. In tubercular phthisis, especially in females, it occasionally accumulates so as to form what is called the fatty liver, which presents a mottled appearance, and resembles much the livers of the shark, cod, and other oily fishes.—P.

the hepatic artery and veins also. It will likewise pass, in a retrograde course, from the biliary ducts to the vena portarum, and to the hepatic artery and the hepatic veins; or from any one of the four orders of vessels into the three others.*

The great peculiarity of the liver is, that venous blood, instead of arterial, is brought to it for the purpose of secretion. Thus the great vein of the chylopoietic viscera, instead of passing to the cava, enters the liver by the transverse fissure, and takes on the office of an artery; its coats, on this account, being much thicker and stronger than those of the hepatic veins.†

—The *acini*, when isolated from the surrounding granulations, and examined with a simple microscope, appear evidently to be ovoid, or rather polyhedrical bodies, with five or six facets, so arranged as to fit exactly to the facets of the surrounding acini, leaving no interval between them, except that occupied by the intervening delicate cellular tissue, which is an extension from the capsule of Glisson.

—Müller, in a few cases succeeded in injecting the biliary canals from the hepatic duct, with size coloured with vermilion, so as to make the liver quite red. The minute acini were then seen to be formed of ramified divisions of the biliary ducts, which terminate in the acini in a tuft of vessels, which divide without diminishing in size, and anastomose together so as to form a net-work. They lie close together, and are difficult to be discovered, even with the microscope; their diameter varies according to Muller, from $\frac{1}{855}$th to $\frac{1}{783}$th part of an inch, but is greater, however, than that of the capillary vessels.

—According to Kiernan,‡ who has investigated this subject with much care, the small granular bodies, so well known to anatomists in the liver under the name of *acini*, should be called lobules, inasmuch as they are found when examined under the micro-

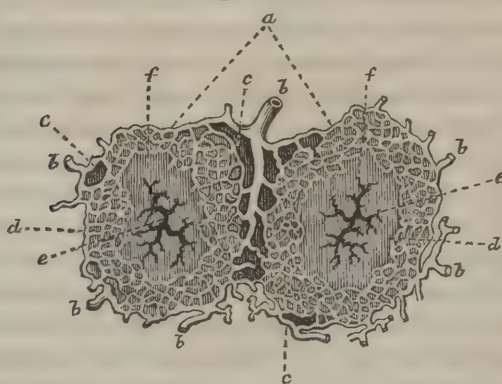
* I have tried the experiment, and find the assertion to be correct.—H.

† A case is related by Mr. Abernethy, in the London Philosophical Transactions, in which the vena portarum terminated in the vena cava below the liver, without communicating with it. The hepatic artery was the only vessel which carried blood to the organ, and was unusually large, the liver being nearly of the natural size. Some bile was in the gall-bladder, but it was less acrid than usual.

‡ Kiernan, on the Anatomy and Physiology of the Liver, Philosophical Transactions of the Royal Society of London, for 1833.—P.

scope, to be apparently composed of numerous smaller bodies, coloured yellow most generally by the bile which they contain.

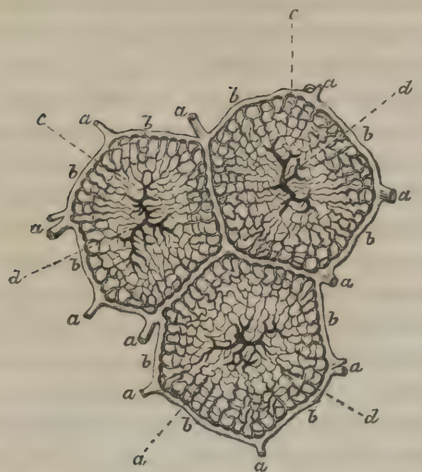
Fig. 53.*



Each of these lobules of Kiernan, (*acini* of most other anatomists) is composed according to him, of a plexus of biliary ducts, (see Fig. 53,) and a plexus from the portal vein, placed on its exterior surface, (see Fig. 54,) of branches of the hepatic artery, and of a branch of a hepatic vein, which occupies its centre, (see Fig. 55.) Nerves and absorbents, it is also probable, enter into its structure, but they cannot be traced upon it. The plexuses formed by the hepatic ducts in each lobule, may be called the lobular biliary, or secreting biliary plexuses. The ducts forming them being exceedingly minute, and anastomosing very freely with each other, as seen in Fig. 53. At their termination, they appear to have no communication with the veins, and hence it is difficult to inject these plexuses with mercury or size, since they generally contain bile which has no place of escape, and which prevents the injecting

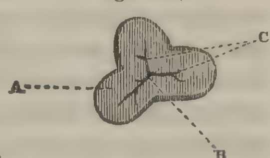
* Fig. 53, represents the interlobular ducts, entering the lobules, and forming the lobular biliary plexuses. *a*, Two lobules. *b b b*, Interlobular ducts. *c c e*, The interlobular cellular tissue. *d d*, The external portions of the lobular biliary plexuses injected. *e e*, The intralobular branches of the hepatic vein. *f f*, The uninjected central portions of the lobules. Mr. Kiernan, has never injected the lobular biliary plexuses, to the extent represented in the cut. It is, therefore, to be considered rather as a diagram, illustrating the structure, in accordance with the results of his different observations and experiments.—P.

Fig. 54.*



fluid in ordinary cases from filling minutely the lobular plexuses. The space between these anastomosing ducts, he considers identical with the acini of Malpighi, which this anatomist has but obscurely described, and which, examined through the microscope, have likewise the appearance of the cells delineated by Mascagni. The lining membrane of the hepatic ducts, like other mucous membranes, pos-

Fig. 55.†



* Fig. 54, represents the interlobular branches of the portal vein, the lobular venous plexuses of the intralobular branches of the hepatic veins of these lobules. *a a a*, Interlobular veins contained in the spaces. *b b b*, The interlobular veins of the fissures and which with the veins in the spaces, form venous circles round the lobules. This is the appearance which the venous circles present when examined with a common magnifying glass. They are, however, formed by numerous, and not by single branches, as represented in the figure. *c c c*, The lobular venous plexuses, the branches of which communicating with each other by intermediate vessels, terminate in the intralobular veins. The circular and ovoid spaces seen between the branches of the plexuses, are occupied by portions of the biliary plexuses, constituting the acini of Malpighi. *d d d*, The intralobular branches of the hepatic veins, in which the vessels of the plexuses terminate.—P.

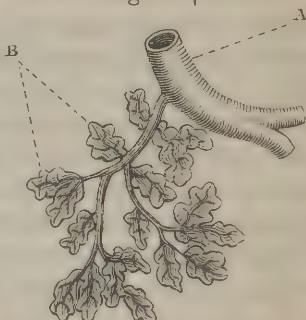
† 55, *a*, A transverse section of a lobule. *b*, The divided central intralobular vein. *c*, The small veins, terminating in a central vein.—P.

sesses many mucous follicles, as seen in Fig. 56. They are here arranged in rows, and from them is derived all the mucus that is admixed with the bile. In each lobule, the portal veins ramify, as seen in Fig. 54, among the branches of the biliary plexus, and finally terminate near the centre of each lobule in the hepatic veins. The hepatic veins are very peculiar. A branch arises from the centre of each lobule, as seen in Fig. 57; and each intralobular branch divides into several capillary filaments, to receive the blood of the portal branches, so that each lobule seems to be placed upon one of the branches of the hepatic veins, as a leaf upon its central stem.

Fig. 56.*

—Each of these branches opens by a minute orifice, directly into one of the divisions of the venæ cavæ hepaticæ, this system of veins having no cellular sheath, or capsule surrounding it, as is the case with the vena porta, but is directly in contact, throughout its whole course in the liver with the bases of the lobules. The hepatic arteries, distribute their branches in the coats, of the hepatic ducts, of the vena portarum and of the hepatic veins; and the veins in which these arterial capillaries terminate, always consist, according to Mr. Kiernan, of the radical branches of the vena portarum. Thus, the hepatic arteries, and the portal branches form the vasa vasorum of all the different vessels and ducts of the liver, and all the blood of the hepatic arteries, passes first into the portal system and thence into the hepatic veins, in

Fig. 57.†



* Fig. 56, represents the internal surface of a small hepatic duct, with its follicles arranged in two longitudinal lines.—P.

† Fig. 57, *A*, An hepatic vein. *B*, Lobules arranged around the intralobular branches of the hepatic veins, as they are frequently seen at the posterior part of the concave surface of the liver. This arrangement is more distinctly seen in the liver of the sheep than in the human liver. These lobules are parallel to the surface.—P.

its circulation through the liver. For these reasons, Mr. Kiernan believes the bile secreted solely from the blood of the portal veins. For even in the well known case mentioned by Mr. Abernethy, where the vena porta terminated in the vena cava without passing through the liver, he found the hepatic arteries much larger than usual, and the portal branches into which they terminated in their course through the liver of corresponding developement; so that even in cases of that sort, the biliary secretion is made not from arterial blood, but from that of the portal veins. The capsule of Glisson is a cellular sheath which extends around the hepatic artery, vein and duct, accompanying their minutest ramifications, up to the lobules, and terminates by forming a delicate capsular investment to each of the individual lobules. It serves, according to Kiernan, like the pia mater of the brain, as a nidus or bed in which the larger branches of these vessels may subdivide before entering into the delicate structure of the lobules. In the interlobular spaces, filled up with the tissue, the portal veins form a sort of vascular circle as seen in Fig. 53.

—It has been asserted by Ferrein, Autenreith, Andral and others, that there are two substances in the liver, a cortical and medullary, or red and yellow; the former of which was exterior and the latter central, in each lobule. This has been denied by Cruveilhier and Müller; and Kiernan has shown that this difference in colour, depends upon the separate congestion of one of the different system of vessels, for such is the great vascularity of the liver that it is usual after death to find one or other in a state of congestion. By injecting moderately, a coloured fluid into the hepatic veins, he found he could colour red, even in the healthiest liver, the central parts of the lobules; by using more force he could colour the whole substance of the lobule, by the blood passing into the portal banches. By injecting into the portal system under similar circumstances, the outer part of the lobule was first coloured. The yellow colour of these acini or lobules is owing, according to Cruveilhier, to a congestion of bile in the radicles of the biliary ducts. The opinions of this anatomist coincide in the main in regard to the structure of the

acini, with those of Mr. Kiernan. He believes, however, that the termination or rather origin of the branches of the biliary duct is from the centre of each acinus, and that immediately around this is a vascular circle formed by the radicles of the hepatic intralobular vein, while the portal system forms a circle extrinsic to the whole. He also believes that there is a part of the outer surface of each lobule, which is uninjectable, spongy and porous, and serves the part of a filter.*

The *Biliary* or *Hepatic Duct* is formed of very minute vessels, which originate in the acini above described: these unite together like veins until they form considerable branches, which finally compose the great ramifications of the biliary duct. This duct is very strong and firm, and on its internal surface are the orifices of many mucous follicles or ducts. It passes from the transverse fissure of the liver, with the hepatic artery, as before described, and at the distance of an inch and a half or two inches from the fissure, it unites with a duct from the gall-bladder, which is called the *Cystic Duct.* This duct is nearly equal in length to the hepatic, and after running almost parallel to it, at length unites so as to form an acute angle with it. The cystic duct is smaller than the hepatic, and they unite much like two branches of an artery.

The *Gall-Bladder*, from which the cystic duct arises, has the shape of a pear, with a very long neck, curved in a way to be hereafter described. It is situated in a superficial pit or cavity in the concave surface of the right lobe of the liver; and its fundus, or basis, often projects a small distance beyond the anterior edge of the viscus. Its position is such, that it extends from before backwards, and inclines rather to the left; of course, therefore, when the subject lies on his back, the bottom of the bladder is the uppermost part of it: when he lies on the left side, it is also higher than the neck; and when he lies on the right side it is the lowermost.

The gall-bladder consists of an internal coat, and one that is cellular or nervous, and has somewhat of a fibrous appearance. This coat connects the gall-bladder to the surface of the pit or

* Anat. Descript. T. ii. p. 575.

cavity in which it lies. The peritoneal coat of the liver is extended from the surface of the viscus over that part of the surface of the gall-bladder which is not in contact with it.

The internal coat has a peculiar structure, with a faint resemblance to that of the villous membrane. It is so arranged as to form very fine folds, which have various directions: in some places they make a net-work; in others, as the neck of the bladder, they are longitudinal. Many mucous follicles exist on its internal surface.

The neck of the gall-bladder is suddenly bent down or curved upon itself, and twisted, so that it resembles the neck of the swan, when the head of that bird is applied to one side of its breast.

A branch of the hepatic artery, which leaves it before it enters the liver, is appropriated to the gall-bladder, and is, therefore, denominated the cystic artery. *The veins corresponding to this artery empty themselves into the vena portarum.** The lymphatic vessels are united to those which are found on the lower surface of the liver, and the nerves are derived from the hepatic plexus.

The gall-bladder appears to be merely a reservoir, into which bile passes through its duct in a retrograde direction. If air be blown through the hepatic duct from the liver, it will pass to the gall-bladder almost as freely as it passes to the duodenum.

The biliary duct from the liver, after receiving the duct from the gall-bladder, takes the name of *Ductus Communis Choledochus.* It is wider than either of the other ducts and near three inches in length. It passes down before the vena portarum, and on the right of the hepatic artery, to the posterior surface of the right extremity of the pancreas. It passes through a small portion of that gland, and then perforates the muscular coat of the duodenum; after which it proceeds from half an inch to an inch between this coat and the villous, and opens into the cavity of the intestine. The orifice forms a tubercle which extends lengthwise of the intestine, and is rounded above and pointed below, with a slit in it. While this duct is in contact with the pancreas,

* It has been justly observed by John Bell, that the veins would not terminate thus, if bile were secreted by the gall-bladder.

a duct from that gland generally opens into it, so that the biliary and pancreatic fluids enter the duodenum by the same orifice; but sometimes the pancreatic duct opens into the duodenum, by a distinct orifice, very near to that of the biliary duct.

The *Bile*, or fluid secreted by the liver, appears to answer a twofold purpose in the animal economy. It produces a chemical effect upon the alimentary mixture which passes from the stomach through the intestines; and it increases the peristaltic motion of those important organs.

By an inverted action of the duodenum, some of this fluid is frequently carried upwards into the stomach: it then often produces only slight derangement of the functions and sensations connected with that viscus; but sometimes *violent vertigo, and even convulsions*, seem to have arisen merely from the presence of a large quantity of bile in the stomach: for they have gone off completely upon the discharge of bile by vomiting.

Notwithstanding these effects of bile in certain cases, in which a great deal of it exists in the stomach, it is often carried into the mass of blood in large quantities, and appears to be mixed with the serum, and to circulate through the body, without producing any very sensible effect: thus many persons who are deeply tinged by bile in their blood, experience but few effects that çan be imputed to the mixture of it with the circulating fluids: and neither the brain nor the heart appears to be much influenced by the circumstance.

Bile is miscible with water and with alcohol, and also with oily substances; and it often assumes a green colour, when mixed with acids. The colour of the alvine discharges is derived from the bile, and they are therefore sometimes very green, when the acetous fermentation takes place in the contents of the stomach and bowels.

It is asserted by some chemists, that ten parts in eleven of the human bile consist of water; that albuminous matter composes about one-forty-sixth part of it; and that there is nearly an equal quantity of resinous mater in it. There is also a small quantity, (one part in 244,) of uncombined soda dissolved in it, and a small quantity of neutral salts, consisting of soda combined with the phosphoric, sulphuric and muriatic acids. In addition to these is a very small quantity of phosphate of lime and of oxide of iron, and some yellow insoluble matter.

The bile in the *Gall-Bladder* is generally more viscid than that which is found in the *Hepatic Duct.*

Of the Pancreas.

The pancreas is a glandular body, which has a strong resemblance to the salivary glands in several particulars. It is seven

inches in length, and is irregularly oblong in its form, one extremity being much larger than the other. Its large extremity is in contact with the duodenum, and it extends from this intestine in a transverse direction to the spleen, to which it is connected by the omentum and by blood-vessels. It is not invested by the peritoneum, but is situated in the space which exists between the two lamina of the mesocolon, as they proceed from the back of the abdomen, before they come in contact with each other. It is anterior to the aorta and vena cava, and to the mesenteric vein, or main branch of the vena portarum; being connected to these parts by cellular membrane. At the right extremity, which is connected with the duodenum, is a process of the gland that extends downwards in close contact with the intestine. This is called the head of the pancreas, or the lesser pancreas.

The position of the pancreas is such, that one of its surfaces looks forwards and rather upwards, and the other backwards and downwards; one edge is of course posterior and superior, and the other interior and inferior. The posterior of these edges is much thicker than the other, and has a groove or excavation which is occupied by the splenic blood-vessels.

This gland differs from the other large glands of the abdomen, inasmuch as it has not a large artery particularly appropriated to it; but instead of this, it receives branches from the contiguous arteries.

The arterial blood of this gland is partly supplied by the splenic artery, which, in its course from the main trunk of the cœliac to the spleen, while it is in the groove at the edge of the pancreas, sends off into the gland one considerable branch called the great pancreatic, and a number of small branches, which go off in succession. In addition to these, the pancreas receives vessels from one of the branches of the hepatic artery, before it sends off its great ramifications, as well as small twigs from several other contiguous arteries. The veins correspond with the arteries, but ultimately are discharged into the vena portarum.

The pancreas resembles the salivary glands in colour, and

also in texture; for it is of a dull white colour with a tinge of red, and it appears to consist of small bodies of a granulated form, which are so arranged as to compose small masses or lobes that are united to each other by cellular membrane. Each of these granulated bodies receives one or more small arterial twigs, and from it proceeds not only a vein but a small excretory duct, which, uniting with similar ducts from the adjoining granulated portions or acini, forms a larger duct in each lobe or mass; these open into the great duct of the gland, which proceeds through it lengthwise from the left extremity, in which it commences, to the right.

This duct is situated in the body of the gland, which must be dissected to bring it into view. It is thin and transparent, like the ducts of the salivary glands, and is rather larger in diameter than a crow's quill. In its progress towards the right extremity of the gland, it gradually enlarges, and commonly receives a branch from the part called the lesser pancreas. It most commonly unites with the biliary duct before it opens into the duodenum: sometimes these ducts open separately, but very near to each other. They penetrate the coats of the intestine, rather obliquely, and between four and five inches from the pylorus. This canal is sometimes called *Ductus Virsungii*, after an anatomist who published a plate of it.

The pancreas has an irregular surface, and no coat which covers it uniformly. It is invested by cellular membrane, which also connects its different lobes to each other. Absorbent vessels and nerves are traced into it.

The portion called the lesser pancreas adheres to the duodedum, and when it is enlarged by disease, the passage of aliment through that intestine is much impeded, and sometimes completely obstructed.*

It is now generally believed that the fluid secreted by the pancreas is similar to that which is produced by the salivary glands.

* In several cases where examination after death evinced that the pancreas had become enlarged and indurated, particularly at the right extremity, the principal symptoms were *jaundice; great uneasiness after taking food; vomiting some time after eating, but not immediately; extreme acidity of the matter rejected.*

Size of the Spleen.

The spleen is a flat body of a bluish colour, and an irregular oblong form, with thick edges, which are indented in some places.

It is various in different subjects, both in size and form. Its most common size is between four and five inches in length, and about three or four inches in breadth; but it has often been found of more than four times this size; and it has also been seen not much longer than an inch. Its ordinary weight is between six and nine ounces; but it has varied in different subjects from eleven pounds to one ounce. It is supposed, by many physiologists, that it frequently varies in size in the same individual.

It is situated in the left hypochondriac region, in contact with the diaphragm, below the eighth rib. The position of the spleen is somewhat oblique,—one extremity being directed downwards and rather forwards, and the other upwards and backwards; but when the stomach is distended, the lower end of it is pushed forward by the great extremity of that viscus.

In general it is so deeply seated in the left hypochondriac region, that it is out of view when the subject is opened in the ordinary way: but in some cases of enlargement, after the intermitting fever, it has extended downwards, nearly as low as the pelvis; and towards the right side beyond the umbilicus.

The external surface of the spleen is convex, in conformity to the surface of the diaphragm, with which it is in contact. The internal surface of the spleen is irregularly concave, having a longitudinal fissure which divides it into two portions.

The spleen is invested by the peritoneum, one process of which is often extended from the diaphragm, above and behind it, in the form of ligament. Another process of the same membrane is extended to it from the great extremity of the stomach. The peritoneum is also continued from the spleen in the form of omentum, (*gastro-splenic.*)

Within this peritoneal covering is the proper coat of the spleen, which is so closely connected to it, that many anatomists have considered them as one membrane: they are, however, very

distinct at the great fissure, but the external coat is extremely thin.

The proper coat of the spleen is not very thick; it is dense and firm, and somewhat elastic, *but not much so.* It is partly transparent.

The spleen has a large artery, which is one of the three great branches of the cœliac. This vessel runs in an undulating manner in a groove in the upper edge of the pancreas, and in this course sends off many small branches to supply that gland. The splenic artery, before it arrives at the spleen, divides into five or six branches, which are also undulating in their progress, and penetrate into the body of the viscus at the above mentioned fissure. These branches are distributed to every part of the viscus, and ramify minutely.

From these branches, or from the main trunk before it ramifies, three or four smaller branches proceed to the left extremity of the stomach. They are called vasa brevia or arteriæ breves.

The arteries which enter the spleen are accompanied by veins that emerge from it, and unite to form a great trunk. This trunk observes a course corresponding to that of the splenic artery, and receives veins from the stomach and pancreas, which correspond with the arterial branches sent to those organs. The splenic vein is one of the principal branches of the vena portarum.

The splenic artery is very large in proportion to the viscus to which it is sent, and the vein is unusually large in proportion to the artery. The vein is also very tender and delicate in its structure.

The absorbent vessels of the spleen are very numerous. It has been asserted, that when those of the *external* coat of the spleen are injected, they are sufficient to form a fine net-work on it. The absorbents of the deep-seated parts unite to the superficial at the fissure where the blood-vessels enter. They terminate in the thoracic duct, after passing through several lymphatic glands.

The nerves of the spleen are derived from the solar plexus: they form the plexus around the vessels, and accompany them through the viscus.

The spleen consists of a substance which is much softer than that of any other viscus of the abdomen. This substance is made up either wholly or in great part of the ramifications of the splenic artery and vein, which are demonstrated by injections to be very minute and numerous in this body. There are also many fine white cords, like threads, which pass from the internal surface of the inner coat of the spleen in its soft substance, in which some of them ramify. These cords connect the substance of the spleen pretty firmly to its coat, and they seem to have the effect of rendering the exterior part of the substance more firm and dense than the internal. They are particularly conspicuous if the spleen be immersed in water, and the coat pulled off while it is in that situation.

The spleen has a strong resemblance to the glandular organs, *but has no excretory duct*, and its particular function is not very obvious: for these reasons the structure of this organ is a subject of very interesting inquiry.

Malpighi, who took the lead in researches of this nature, before injections of the blood-vessels with wax were in use, after investigating the structure of the spleen by long maceration, by boiling, by inflation, by the injection of ink or coloured fluids, and by examination with microscopes, declared that its structure was cellular; that the cells communicated more freely with the veins than the arteries; and that they might be considered as appendices of the veins. He also asserted, that a large number of white bodies or vesicles were to be found in those cells and throughout the whole substance of the spleen, which were in bunches like grapes, and preserved their whitish colour although the vessels around them were injected with a coloured fluid. This description of Malpighi appears to have been admitted by some of the very respectable anatomists who were contemporary with him; but it was zealously opposed by Ruysch, who exhibited the spleen so completely injected with wax, that it appeared to be composed entirely of vessels.*

* Two plates, taken from drawings of these preparations are published in Ruysch's Works. One is attached to Epistola Problematica Quarta, in the second volume; and the other in Thesaurus Septimus, in the third volume.

Ruysch appears to have paid great attention to this subject, and to have made many preparations of the spleen. From these he derived the opinion, that the substance of this organ was entirely composed of arteries, veins, absorbent vessels and nerves; and that if it were properly injected before it was dissected, no other structure would be found. He stated, that the minute ramifications of the blood-vessels appeared to have acquired a peculiar quality, and were so soft and delicate that their texture was destroyed by the least friction; and that by the slightest degree of putrefaction they appeared to be reduced to a fluid state. He also denied the existence of cells, or of the whitish bodies described by Malpighi.

The question thus at issue between these great masters of their art was very carefully examined by M. De La Sone, a French Physician, whose observations are published in the Memoirs of the Academy of Sciences for 1754. After repeating the processes of each of these anatomists, and instituting some others in addition, he adopted the opinion that there was in the texture of the spleen, a pulpy substance which was not a mere coagulum, but which, however, could not be injected.

He derived this opinion from this fact among others. After macerating the spleen a considerable time, and injecting water into the vessels until it returned colourless, he injected ink, and confined it some time in the vessels by tying them: he then allowed the ink to flow out of the vessels, and made various sections of the spleen; but no ink appeared in the pulpy substance, although it was visible in many small vessels which ramified in that substance. He observed that this could not have been the case, if the pulpy substance had been composed entirely of vessels, as was supposed by Ruysch.

He also examined the spleen after it had been injected with wax, according to the manner of Ruysch, and believed not only that the pulpy matter remained uninjected, but that Ruysch himself, in his own preparations, removed this substance, supposing it to exist for the mere purpose of connecting the vessels to each other.

To see the blood-vessels in the same state of distention in which they were during life, he tied the splenic vessels in a living animal, and removed the spleen with the ligatures on the vessels. In this situation he boiled it, and then examined the appearance of the vessels and the pulpy substance.—From these, as well as his other observations, he decided, that the pulpy substance did not consist entirely of vessels, but was an additional and different structure.

He also suggested, that as the brain and muscular fibres were so covered by blood-vessels in the injected preparations of Ruysch, that they appeared to be composed entirely of vessels, when in fact they consisted of a different substance, so the pulpy substance of the spleen was covered or obscured by the blood-vessels which passed through it, without constituting its whole substance.

He confirms the account of Malpighi respecting the *Whitish Vesicles or Follicles,* and states, that in a majority of cases they are not to be discovered without a particular preparation; but that they are generally made obvious by long maceration of the spleen in water. In his opinion they are the most essential part of the organ.

Notwithstanding these investigations of M. De La Sone, the question respecting the structure of the spleen remains not completely decided even to this day.

Haller, who was perfectly well acquainted with the subject, inclined to the opinion of Ruysch; while Sabatier adopted completely the opinion of De La Sone.

It appears from the statement of Gavard, that Desault did not admit the existence of the transparent bodies; although he believed that the pulpy substance of the spleen consisted of cells which resembled those of the cavernous bodies of the penis.

Boyer, whose descriptions of the animal structure appear to have been formed with scrupulous exactitude, admits the existence of transparent bodies; sometimes so small as to be scarcely visible, and sometimes as large as the head of a pin. He ob-

serves, that the best method of examining them is to place a very thin slice of the spleen between the eye and a strong light, when the transparency of these bodies occasions the slice of the spleen to appear as if perforated.

As to the general structure of the pulpy substance, he avows himself unable to decide respecting it; but observes, that upon examining the cut surface of the spleen, you perceive black liquid blood flow from the vessels; if you then scrape this surface, you may express easily a species of sanies different from that which flows from the vessels, which, after exposure, becomes red, and resembles coagulated blood; whether this is contained in the capillary vessels, or in the cavities of this organ, he acknowledges himself unable to determine.

Notwithstanding the sentiments of these French gentlemen, many of the British anatomists, who are entitled to great attention on account of their skill in minute injections, have adopted the ideas of Ruysch. Among these are to be mentioned the late Dr. F. Nicholls, and many of the anatomists of London, as well as the second Professor Monro, of Edinburgh. There are, however, two remarkable exceptions to this account of the British anatomists. The late Mr. Falconer, who wrote a dissertation on the situation and structure of the spleen, which contains the sentiments of the late truly respectable Mr. Hewson,* after stating that the organ was extremely vascular, so that when injected it appeared like a mere congeries of vessels, makes this unequivocal assertion—that there are innumerable cells dispersed throughout the whole substance of it, which are so small that *they are only to be discovered by the aid of a microscope;* and are to be seen after steeping a thin piece of spleen, the blood-vessels of which have been minutely injected in clear water, during a day, and changing the water frequently. He also adds, that the ultimate branches of the arteries and veins form a beautiful network on each cell; and that these cells are sufficiently distinguished from the irregular interstices of the cellular substance, by their round figure and their great regularity.

* See Experimental Inquiries, vol. iii.

Sir Everard Home, in his papers on the structure and uses of the spleen, confirms the account of the vesicles in this organ; and adds that these vesicles are occasionally seen in a distended and in a contracted state. That when distended they are twice as large as when contracted, and are distinguishable by the naked eye; whereas when contracted, they require a magnifying glass to be distinctly seen. These observations appear to have been made upon quadrupeds.*

Professor Soemmering appears to unite in the *general* sentiment of the British anatomists, that the spleen is *simply vascular*. He says, that the tuberculi which sometimes appear in it, when examined with a magnifying glass, appear to be composed entirely of vessels.

There are, therefore, two questions not perfectly decided respecting the spleen.

First. Whether its general structure is simply vascular; or whether there is any other structure either cellular or more substantial, which composes its general bulk.

Second. Whether the small transparent vesicles, originally described by Malpighi, are to be regarded as essential parts of the structure of the spleen.

With respect to the first question, the injections of Ruysch, and of the British anatomists in general, and even of Mr. Hewson, as well as of Haller and Soemmering, seem to afford *positive* facts in opposition to those of a *negative* kind adduced by M. De La Sone, and render it highly probable that the *general* structure is simply vascular.

But the second question stands on different grounds. The existence of small transparent vesicles, although denied by Ruysch, and neglected by the British anatomists in general, was asserted as a *positive* fact by Malpighi and De La Sone; and their assertions have been confirmed, not only by most of the French anatomists, but also by Hewson and Home among the British.

The sentiments of physiologists respecting the functions of the spleen, are more discordant than those of anatomists respecting

* See the London Philosophical Transactions for 1808.

its structure; although the subject has been considered by many authors of great ingenuity.*

—The spleen is met with only in vertebrate animals, and in them its presence is nearly constant. The whitish rounded corpuscles of Malpighi, which are found in many animals and occasionally in man, and are visible to the naked eye in the red substance of the liver, have been more recently described by Dupuytren and Assolant as grayish bodies, without any cavity in their interior, one-fifth of a line in diameter, and so soft as to take the liquid form when raised on the knife. Meckel considers them probably hollow, at all events, very soft and vascular.

—Müller considers them as growths or processes connected with the sheaths with which the capillary branches of the splenic artery are provided. But of their intimate texture nothing is known.

—The pulpy substance of the spleen consists of a mass of red-brown granules, as large as the red particles of the blood, but differing from them in form, being very irregularly globular.

—These granules are easily separable from each other, and in their midst the minute arteries ramify in tufts, and terminate in the plexus of venous canals, in which all the blood of the spleen is poured, before it is carried out of the organ by the splenic vein. There are no distinct cells in the spleen; those spaces seen in sections of the organs which have been mistaken for cells, are divided venous canals exceedingly thin and delicate. When the spleen is inflated with air, these vessels are distended, and assume a slightly cellular appearance.

—The spleen is now generally considered as belonging to the class of erectile tissues, and to serve as a diverticulum to the blood, which accumulates temporarily in the venous plexuses of the stomach during digestion. Its uses in the economy are by no means well understood, and in health or disease, seems to have but little functional connexion with other organs. In the female, it appears to sympathize more with the organs of generation than any others. Its extirpation in animals may take

* See M. Lieutaud, Elementa Physiologiæ; Hewson's Experimental Inquiries, vol. iii.; Dr. Rush, Medical Museum, vol. iii.; and Haller, Elementa Physiologiæ, tom. vi. page 414.

place without destroying life. This operation was practised by Dr. Schultz,* twenty-seven times in dogs, cats, goats, and rabbits, and of which but one died from the operation. When the wound had healed, he remarked but little functional disturbance in any of the organs of the body except the generative. The chyle drawn from the thoracic duct, presented the same appearances as that of animals in which the experiment had not been practised; which is counter to the opinion of Tiedemann and Gmelin, who affirm the use of the spleen to be that of furnishing through its numerous absorbent vessels, a fluid which reddens and assists in animalizing the thoracic chyle.

—In the animals operated upon, the power of procreation was greatly impaired, though not entirely destroyed.

* Hecker's Annalen, tom. xii.

CHAPTER IV.

OF THE URINARY ORGANS AND THE GLANDULÆ RENALES.

THE urinary organs consist of the *Kidneys*, which are situated in the lumbar regions; of the *Bladder*, which is in the pelvis; of the *Ureters*, which are flexible tubes or canals that pass from the kidneys to the bladder; and of the *Urethra*, or tube through which the urine is discharged from the bladder.

These organs have but little connexion with the peritoneum. The kidneys are behind it, and a considerable quantity of cellular membrane is placed between them and it. The ureters are also behind it; and but a part of the bladder is invested with it.

The *Glandulæ Renales* are described with the urinary organs, on account of their contiguity to the kidneys; and to avoid a derangement of the natural order of description, they are considered first.

The urethra pertains to the organs of generation as well as to the urinary organs, and can be described most advantageously with them.

Of the Glandulæ Renales. (Renes Succenturiati, Capsulæ Atrabiliares.)

These are two small bodies situated on the psoas muscles, one on each side of the spine, behind the peritoneum and above the kidney, being in contact with its upper and anterior edge. They have an irregular semilunar figure with three sides, one of which is accommodated to the convexity of the kidney. Their colour is commonly a dull yellow.

The appearance and texture of these bodies have some resemblance to those of glands, and hence their name, but they have no excretory duct.

When they are laid open by an incision, a cavity often appears, which is somewhat triangular, and from the lower part of it a small thin ridge arises.*

A small quantity of fluid is generally found in it, which has a very dark colour in adults, is yellowish in young subjects, and red in infants.

These bodies have not a single artery appropriated to them, as the spleen has, but receive small branches from several contiguous sources; namely, from the arteries of the diaphragm, from the cœliac artery or the aorta, and from the arteries of the kidneys. There is generally one principal vein, as well as some that are smaller, belonging to each of these bodies: the large vein, on the right side, generally opens into the vena cava; and, on the left, into the left emulgent vein.

These bodies were first described by Eustachius, and have been regarded with attention by many anatomists since that period. They exist in a great number of animals; but their nature and functions are altogether unknown.

—Rayer,† adopts the opinion of Meckel, that in the normal state there is no cavity whatever in the renal capsules. Whenever I have observed this cavity in my dissections, it has been always filled with dark blood or a yellowish albuminous fluid, and the walls of the cavity have presented an irregular appearance, though having the general triangular form of the gland. In the healthy state, the renal vein can be traced into the centre of the gland which then presents a spongy appearance.
—Rayer considers the cavity as always produced by hæmorrhage, arising from a rupture of some of the lax vessels of the capsule, which causes a forcible separation of the soft tissue of the gland. He describes several cases of what he calls apoplexy of the gland, where a large amount of blood was collected in a cyst formed from the gland. Müller believes that the developement of these glands is in some measure connected with that of the generative organs.—

* The cavity in these bodies has sometimes been sought for in vain. Haller found it in sixteen cases out of nineteen.

† Sur Les Maladies des Reins.—P.

Of the Kidneys and Ureters.

The kidneys are two glandular bodies which secrete the urine. They are of a dull red colour, and their form has a strong resemblance to that of the bean which bears their name. They have a peculiar texture, which is uniform, and not granulated or composed of acini; and they are covered by a thin delicate tunic, which has no connexion with the peritoneum.

They are situated in the lumbar regions of the abdomen, one on each side of the spine. They are opposite to the two last dorsal and the two first lumbar vertebræ. They rest principally upon the psoas and quadratus lumborum muscles, and their position is oblique; the concave edge presenting inwards and forwards, the convex edge backwards, and the upper extremity approaching nearer to the spine than the lower.

The *Right Kidney* is situated rather lower than the left: it is below the posterior part of the right lobe of the liver, and behind the duodenum and the colon. The *Left Kidney* is below the spleen, and behind the descending portion of the colon. Each of the kidneys is below and very near to one of the glandulæ renales.

They are surrounded with a large quantity of lax adipose membrane, which in corpulent persons forms a very large mass of adeps around them; while in the emaciated they are surrounded with a membrane almost free from fat. Each kidney has two broad sides, two extremities, and two edges. The side or surface which is posterior, when the kidney is in its natural situation, is rather broader than the other. The upper extremity, or portion, is also broader and larger than the lower. The edge which is posterior and external is regularly convex; the anterior edge is concave; but the concave edge or margin is not very regular. In the middle it is largely indented; in this indentation is a deep fissure, which separates the two broad surfaces or sides of the gland from each other; and here the breadth of the posterior surface is evidently greater than the anterior.

Each of the kidneys receives a large artery, which proceeds

immediately from the aorta, nearly in a rectangular direction. A vein, which opens into the vena cava, accompanies the artery. It is obvious, from the situation of the kidneys with respect to the great vessels, that the artery on the right side must be longer than that on the left, and that the reverse of this must be the case with the veins; the veins are also anterior to the arteries. At the great fissure these vessels divide into several branches, which enter the kidney at that place. The branches of the vein are before and above; those of the artery are below, and in the middle. Surrounded more or less by the branches of those vessels, is a membranous sac; the breadth of which extends from above downwards. This sac terminates in a tube that proceeds from the lower part of the fissure down to the bladder. The sac is denominated the pelvis of the kidney, and the tube a ureter: each of these parts will soon be more particularly described.

The substance of the kidney, as has been already said, is uniform in its texture, and of a reddish brown colour. When it is divided by an incision made lengthways, and from its convex to its concave edge, there appears to be a small difference in the different parts of it. The exterior part, which is called cortical, is rather more pale in colour and softer in consistence than the internal part. It varies in thickness, so that some writers have described it as equal to two lines, and others to one-third of the kidney. In a majority of subjects it will be found between the two statements.

The interior part is called medullary, or tubular, and appears to be composed of very fine tubes. These tubes are so arranged, that a number of papillæ or cones are formed by their convergence, and project into the fissure of the kidney. These papillæ have been supposed to consist of a substance different from either of the two above mentioned, but they appear to be formed merely by the tubular part.

The arteries, accompanied by corresponding veins, and by nerves and absorbent vessels, after ramifying in the fissure of the kidney, proceed into its substance, and continue their arborescent ramifications until they have arrived very near the exterior sur-

face. They are so uniformly distributed to the different parts of the organ, that when the blood-vessels are injected with wax, and the substance of the kidney is removed from the injected matter, as is the case in corroded preparations, the injection exhibits accurately the form of the kidney.

The *large branches* of the blood-vessels occupy the vacuities between the papillæ in the fissure of the kidney. When they penetrate the substance of the kidney, they are enclosed by sheaths which are derived from the coat of the gland, and are surrounded by membrane which frequently contains adeps.

There are commonly ten or twelve papillæ in the fissure of each kidney, but there are sometimes more and sometimes less than this number. These papillæ are surrounded by a membranous sac of a corresponding form; the papillæ being a cone, and the sac resembling the upper part of a funnel. The sac is therefore called an infundibulum, or calyx. Sometimes there are two papillæ in each infundibulum, and then the form of the sac is not so regular. The infundibulum adheres to the base of the papillæ, but lies loose about the other parts of it. Each infundibulum communicates at its apex with the pelvis of the kidney.

The *Pelvis*, as has been already mentioned, is a membranous sac which terminates in the ureter, exterior to the kidney. This sac generally divides itself, in the fissure of the kidney, into three large irregular branches, called *calices*, each of which very soon terminates in three or four of the *infundibula* above described. That portion of the sac which terminates in the ureter is exterior to the kidney.

When the interior parts of the kidney are exposed to view, by the section above mentioned, after the arteries and veins have been minutely injected, the cortical part will be found to consist almost entirely of the minute ramifications of these vessels. Among them are some small bodies, which are dispersed through the substance, like berries on a bush: these are asserted also to be composed of vessels.

The tubular part certainly proceeds from this vascular corti-

cal substance: for Ruysch, and after him several other injectors, have filled these tubes with injections thrown into the arteries.

The tubuli, of which this part is composed, seem to arise obscurely from the cortical part. They soon assume somewhat of a radiated direction, and are finally arranged so as to form the papillæ or cones above described.

On these papillæ or cones some of them can be traced, uniting with each other, to form larger tubes, which terminate on the surfaces of the papillæ, in orifices large enough to be seen distinctly. From these orifices urine may be forced out by compressing the papillæ. On this account the tubes have been called tubuli uriniferi.

—The minute round bodies which are distributed among the arteries and veins of the cortical portion, and are visible to the naked eye, are called the corpuscles of Malpighi. These bodies, Malpighi and Schumlansky, believed to be hollow sacs, with vessels ramifying on the parietes, and which secreted the urine. Ruysch, Hewson, and more recently Huschke, and Müller, have shown that they are formed entirely of an agglomeration of minute vascular branches, and are mere reservoirs of blood.

—The *conoidal*, *medullary* or *tubular* portions of the kidney, are from twelve to eighteen in number. The bases of these are rounded, and turned to the cortical matter which covers them, to the thickness of two lines, and dips in for a much greater depth between their rounded margins. The arteries and veins send up their ramifications to the cortical matter, between these different conoidal bodies so as to separate them from each other. The conoidal bodies terminate in the infundibuli, in little nipple-like projections, called *papillæ renales.* At the apex of these, there is usually a depression, called *foveala.* There are usually but ten or twelve of these papillæ, two of the conoidal bodies terminating in several places in a common papilla. The conoidal bodies being pyramidal in their shape, are sometimes called the pyramids of Malpighi.

—Each of these conoidal bodies or pyramids, is composed of an immense number of minute tubes, (*tubuli uriniferi,*) which

terminate by a small number of orifices on the surface of its papilla.

—These tubes originate in the cortical portion, in their course through which they are serpentine and tortuous, and are called the ducts of Férrein (*ducti Férreinei;*) the same ducts, as they pass from the cortical matter to the papilla become straight, and are called the ducts of Bellini, from two anatomists who devoted much attention to the structure of the kidney. Férrein ascertained that the general convergence of each cone or pyramid of Malpighi, from its base to its papilla, was caused by the union of many of the ducts together, into common tubes, so as to constitute lesser pyramids, called the pyramids of Férrein, (*Pyramides Férreinei.*) The ducts of each of *these pyramids*, subsequently unite together, so that the convergence is uniform down to the papilla, where for the whole, there appears to be but from twenty to thirty terminal orifices. In each conoidal body, the pyramids of Férrein, are said by that anatomist to be seven hundred in number, which, as the number of cones in a kidney are upon an average about fifteen, would make the whole number of pyramids in the kidney, ten thousand five hundred.

—Again, each of the pyramids of Férrein, is said at its base to be composed of many hundred separate tubes, each of which tubes, according to Eysenhardt, is composed of twenty smaller ones: but the observations of this latter writer, even by the German anatomists, are considered rather as an exaggeration.

—The exact mode of origin of the tubuli uriniferi has been long a question of doubt. According to Krause and Müller, who have recently investigated this subject, they originate as closed tubes, like the ducts of other glands. These ducts, when examined with the microscope in the cortical portion, appeared two or three times less in diameter, than the tubuli seminiferi, and therefore invisible to the naked eye, though they were still much larger than the capillary blood-vessels, which form in the cortical structure of the kidneys a very minute net-work. These ducts of the cortical portion (*ducti Férreinei,*) anastomose frequently with one another; they are flexuous and closely aggregated together, which gives to the cortical matter the appearance of a solid mass.

—From the minute currents of blood with which these vessels supply the walls of the ducts, the secretion of urine, according to Müller, takes place; a part of the contents of the blood-vessels permeating the walls of the ducts, and undergoing in the transit probably some change. It is certain, however, that there is some intimate communication between the origin of the ducts, and the radicles of the veins, even in man and the higher animals. In oviparous animals, as has before been observed, the secretion of urine takes place from a portal vein.

—A fine injecting fluid will pass readily from the veins into the uriniferous tubes; and I find no difficulty in passing air in the retrograde direction, from the ureter into the veins by inflation of the former with a large blow-pipe; the cut extremity of the veins being retained under water, large bubbles of air will be seen to escape from it during inflation. M. Huschke,* was also very successful in passing coloured fluids in the same direction, by the aid of the air-pump. The uriniferous tubes were always well injected, the fluid passing in by the orifices on the papillæ; and in most cases the venous plexus in the cortical structure, was also filled. But in no instance, in man or the inferior animals, did he find the fluid passing into the corpuscles of Malpighi, or into the arteries.

—The average weight of a healthy kidney is from four to five ounces. In the *nephritis albuminosa, granular disease of Bright,* which is an affection of the cortical or glandular substance only, attended with albuminous urine, the first developement of the minute red points, which subsequently become the granulations of Bright, correspond for the most part according to Rayer,† to the highly vascular corpuscles of Malpighi.—

In the fœtal state the kidney is formed of a number of distinct lobuli, each of which consists of a papilla with the cortical matter connected to its base. Soon after birth these lobuli coalesce; and in two or three years the substance of the kidney appears uniform, as above described. In some animals this lobulated structure continues during life: in them, and also in the fœtus, each lobe appears like a distinct organ. Although in the adult kidney this structure has disappeared, the papillæ and the tubular

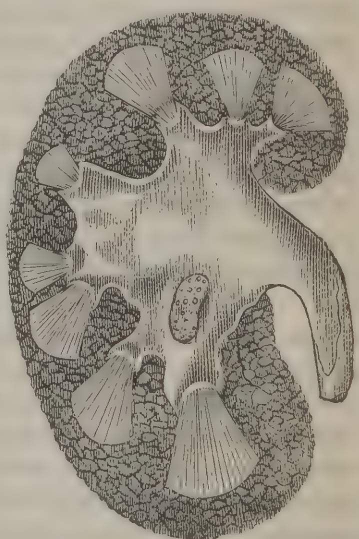
* Isis, tom. xxi.

† Oper. citat.

part connected with them are somewhat detached from each other, in a manner corresponding to their original arrangement. —In the fœtus the renal capsule appears very large, when compared with the kidney itself; which seems to indicate, that that organ performs some office of much importance in the fœtal economy.—

The *Nerves of the Kidneys* originate from the semilunar ganglion, formerly mentioned. They form a plexus round the blood-vessels, and go with them into the gland.

Fig. 58.*



The kidneys have internal and external absorbent vessels, although the external vessels are very small. These absorbents pass through glands in the lumbar region to the thoracic duct.

The *proper* coat of the kidney is said, by some anatomists, to consist of two lamina; but this cannot be shown in common cases. It appears simple in its structure, and very flexible. It is but slightly connected to the glandular substance which it encloses, and may be easily peeled off. It is reflected inwards at the fissure of the kidney, and can be traced inwardly to some distance, forming sheaths for the vessels. In this internal situation it is very thin.

* Fig. 58 is a vertical section of a kidney, in which the ureter is seen entering the organ, and dilating into a large sac called the pelvis. The pelvis is divided into four calices, of which three are seen in part, in this section; each calix is subdivided into four infundibuli, of which, of course part only can be seen in this semi-section of the organ. The striated conoidal bodies are seen terminating by their papillæ in these infundibuli; and in one infundibulum a papilla is seen perforated by foramina, which are the terminal orifices of the uriniferous tubes. Between the rounded bases of the conoidal bodies, and on the periphery of the kidney is seen the cortical substance.—P.

The Ureters.

The pelvis of the kidney terminates exteriorly in the *Ureter*, which is a membranous cylindrical tube, rather flattened, and between three and five lines in diameter, with some variations in this respect.

The *Ureters* descend from the pelvis of the kidney so as to pass obliquely across the psoas muscle and the great iliac vessels. They are behind the peritoneum, but in contact with it. They approach the pelvis near the junction of the os ilium with the sacrum, and thence descend forwards and inwards, surrounded with loose cellular membrane, to the lower part of the bladder into which they are inserted at its external and posterior part. They first penetrate obliquely the muscular coat, and then proceed between the muscular and internal coats from half an inch to an inch, in an oblique direction, from without inwards and forwards, when they terminate by small orifices in the internal coat, each of which is at an equal distance, (rather more than an inch,) from the orifice of the urethra, thus forming a triangle with it.

The ureters are said to have three coats. The exterior appears to be derived from the cellular substance; within it is another, which has been regarded very differently by different anatomists; some considering it as merely membranous, and others as muscular. If the ureter be laid open and the internal coat peeled off, the muscular structure of this coat is often very perceptible.

The internal coat is called villous, or mucous, and is continued from the internal coat of the bladder. Over this coat mucus is constantly spread, which defends it from the acrimony of the urine. It is very difficult to separate the two last mentioned coats from each other.

The ureters receive blood-vessels and nerves from those of the neighbouring parts. Their internal coat is very vascular, and is also very sensible of irritation. The passage of a small urinary calculus can be traced from the pelvis of the kidney to the

bladder, by the exquisite pain and the spasmodic affections which it often excites.

Of the Urinary Bladder.

The urinary bladder is a large sac, of a muscular and membranous structure, which occupies the anterior part of the cavity of the pelvis, immediately within the ossa pubis.

The size of the bladder is in a continued state of variation, according to the quantity of urine secreted. When moderately distended, it is of an irregular oval form, but rather more flat at its lower extremity than above. It varies in form according to the different circumstances of the pelvis to which it has been subjected.

It is fixed firmly and immovably to the pelvis immediately within the symphysis pubis; so that it is always to be found there of a larger or smaller size. This fixture is produced by the attachment of the lower portion of fundus of the bladder to the parts beneath it, but principally by the anterior ligaments of the bladder which proceed one on each side from the lateral surfaces of the prostate gland, and are inserted into the pubis of the corresponding side at the lower part of the symphysis. These ligaments are in fact the extension of a membrane, (called by the French anatomists, the pelvic aponeurosis,) which proceeds from the upper part of the pelvis to the side of the prostate gland and bladder, and which may be seen by turning off the peritoneum from the levator ani muscle.* It is sometimes completely empty, and occupies no more space than the thickness of its coats requires. When moderately distended, it occupies a considerable portion of the pelvis: when distention increases, it presses the parts posterior to it against the sacrum, and extends itself above the brim of the pelvis into the general cavity, rising not only to the umbilicus, but in some cases to the epigastric region.

In males the relative situation of the bladder and rectum is

* See Thesis on Femoral Hernia, &c., by Gilbert Breschet. Paris, April, 1819. Colles' Surgical Anatomy, Dublin, 1811, for a more minute account of this membrane.—H.

such, that the upper and middle part of the rectum is behind the bladder; but the lower part of the rectum, following the curve of the os sacrum and coccygis, is below the posterior part of the bladder.

In females the vagina and uterus are situated between the bladder and rectum; so that the connexion of these last mentioned parts is very different in the two sexes.

The peritoneum is reflected at the anterior part of the brim of the pelvis from the abdominal muscles, which it lines, to the upper part of the bladder, which is generally contiguous to the brim of the pelvis. It continues over to the posterior side of the bladder, and passes down upon it some distance towards the lower part; but before it has arrived at the bottom, it is reflected towards the sacrum.

In males it extends from the bladder to the rectum, and in females, to the vagina and uterus; so that there is a considerable portion of the lower part of the bladder which is not invested by the peritoneum. It also follows, that when the bladder is extended into the abdomen, and rises above the brim of the pelvis, that part of it which presents anteriorly, and is in contact with the abdominal muscles, is without a covering of peritoneum; being below it.

—It is usual for anatomists and pathologists to divide the bladder when moderately distended into four regions, for the purposes of description, viz. The middle part or body, the top or upper fundus, the inferior part or lower fundus, and the neck, at which the urethra commences.

—In the fœtus and young child, the neck of the bladder is the most depending portion. In the adult, the bottom of the bladder is depressed and expanded, so as to form a pouch below the level of the neck, which is technically known as the *bas fond.* In this part the urine first begins to accumulate when the organ has been emptied, and calculi usually lodge.

—The diameter of the bas fond is rather greater laterally than in the antero-posterior direction. Its lateral portions in both sexes are in contact with the levator ani muscles, and correspond to the spaces between the anus and the tuberosities of the ischium.

In the female, its middle portion is in contact with the walls of the vagina; in the male with the rectum in the middle line, and with the vesiculæ seminales and the vasa deferentia upon the side.—

The bladder is composed of a coat consisting of muscular fibres, of a stratum of cellular substance immediately within this, and of an internal lining membrane, which has been called villous; but, as there are no villi perceptible on it, it may be more properly denominated mucous.

It should be observed, that, in addition to these coats, the bladder has a peculiar investment of the peritoneum, as has been already described; and also of the common cellular membrane, which is placed between it in every part to which it is contiguous.

The *Muscular Coat of the Bladder* consists of fibres which are not spread over it of a uniform thickness, but are thin in some places, and in others are collected in fasciculi. They run in every direction: some appear longitudinal, others circular, and some oblique; and there are interstices between them which are occupied by cellular membrane. The longitudinal fibres originate from the lower part of the bladder; and as this is the fixed part of that viscus, it is the place from which these fibres must necessarily act. These fibres are generally exterior. There is no arrangement of the muscular fibres to which the term of sphincter can properly be applied; but many anatomists have thought that the fibres near the neck of the bladder, by their separate contraction, might prevent the escape of urine; this sentiment, however, is contrary to that of several very respectable writers.

The direction of the fibres, taken collectively, is such that, when they all contract, the cavity of the bladder is completely obliterated.

—The longitudinal fibres form the *detrusor urinæ* muscle of some anatomists. Some of these fibres may be traced by very careful dissection, to an insertion in the back part of the prostate gland; others into the fasciæ covering the surface of the gland; and a small delicate band of fibres, according to Harrison, enters the notch at the base of the gland, into which it is sometimes in-

serted, but can frequently be traced forward between the mucous membrane and the gland, in front of which it is inserted by a delicate tendon, at the lower part of the *seminal caruncle* or *caput gallinaginis.* The office of this strip of fibres, is, he thinks, to depress the uvula, and thus open the neck of the bladder, and to draw down the seminal caruncle, (which he considers a vascular erectile body like the glans penis,) into the cavity which surrounds it, called *sinus pocularis*, out of the way of being irritated by the urine. The fibres which cover the prostate gland, connect it with the bladder in urination, and probably force out its mucus to lubrify the passages.

—There has been much contrariety of opinion among anatomists of reputation, in regard to the existence of a sphincter muscle at the neck of the bladder, arising from the colourless appearance and reticulated character of the fibres of the part.

—Those who deny the existence of a sphincter, as Bichat, Cloquet, Marjolin, consider the neck of the bladder made up of elastic fibro-ligamentous tissue, continuous with the longitudinal fibres, and which expands under the action of the detrusor muscle, to give passage to the urine. Those who admit the existence of a sphincter, as C. Bell, Meckel, Horner, Harrison, etc., describe it, however, very differently.

—The inferences drawn from diseased conditions of the organ, are evidently much in favour of the existence of a muscular sphincter; viz. the paralysis and incontinence of urine, resulting from affection of the brain or spinal marrow, and the spasmodic closures of the neck in strangury, resulting from neighbouring disease, or the acrimonious qualities of the urine.

—Harrison,* who has investigated it most recently, thus describes it:—"When the several strata of longitudinal fibres have been raised from the front and lateral parts of this region, the circular fibres of the bladder become distinct, but do not appear so proportionably increased as were the longitudinal; but on detaching more completely the longitudinal strata, down to the circumference of the very opening of the urethra, a distinctly

* Vide article Bladder, by J. Harrison, Cyclop. of Anat. and Physiology.—P.

fibrous, that is, muscular tissue is evident, bounding this opening laterally and superiorly, but not below. This muscular fasciculus is not intimately connected to the general circular coat; it appears redder and of a closer texture, and will be found to be attached to the fibrous or tendinous substance, forming the anterior part of the trigone on each side of the uvula, behind which it does not pass. The longitudinal fibres are inserted partly into this semicircular muscle, much in the same manner as the levatores ani are inserted into the circumference of the anus. This structure we consider to be partly elastic but essentially muscular; it bounds the urethral opening laterally and above, but not below; the slight projection of the uvula in the latter situation, and the elasticity and gentle state of contraction natural to all the sphincter muscles, will preserve this opening in a constantly closed state during the quiescent and normal condition of the parts."
—For a description of the muscles of this part somewhat analogous to the above, see Dr. Horner's Anatomy, vol. ii. p. 80, 4th edit.—

The cellular substance between the muscular and internal coats is dense. It yields in a remarkable manner to distention, and recovers its original dimensions very easily. From its analogy to a similar coat in the intestines, it is called the *Nervous Coat.*

The *Internal Coat* of the bladder is of a light colour in the dead subject, when it has been free from disease. It has been called villous improperly; for the villous structure is not apparent upon its surface. Being continued from the integuments of the body which are extended along the urethra, it has been inferred, that the surface of this coat was formed by the epidermis; and some respectable authors have supposed that they had seen cases in which portions of the epidermis of the bladder had separated and been discharged; but these appearances are very equivocal, and it is by no means certain that an epidermis exists there.*

The fasciculi of fibres of the muscular coat occasion this coat

* In the fauces and the follicles of the tonsils, an effusion of coagulable matter, in consequence of inflammation, often forms crusts that may be mistaken for sloughs of the integuments, although these integuments remain entire.

to appear very irregular, but these irregularities correspond exactly with the arrangement of the fibres of the muscular coat.

When the internal coat is separated by dissection from the muscular, its surface is very smooth and uniform. In the recent subject, when no disease has previously existed, it is *always* spread over with mucus of a light colour, but nearly transparent, which can be easily scraped off. This mucus is spread upon the surface so uniformly, that it must be derived from sources which are situated upon every part of the surface; but these sources are not very obvious. On the membrane of the nose the orifices of many mucous ducts are very visible, but such orifices are not to be seen on this surface.—Haller mentions that he has seen mucous glands near the neck of the bladder; and it is stated by the pupils of Desault, that, in one of his courses, he pointed out a number of these glands, in a subject who had been afflicted with a catarrhal affection of the bladder.

Notwithstanding that the sources of this mucus are obscure, the quantity of it is sometimes immense. In some cases, where the secretion is increased by the irritation of a *calculus* in the bladder, the urine is rendered somewhat viscid and white-coloured by the mucus mixed with it; which, after the urine has been allowed to remain for some time, subsides in such quantities as demonstrates that many ounces must be secreted in the course of the twenty-four hours. The same circumstances occur without the irritation of calculus, in the disease called catarrhus vesicæ.*

It is probable that, in healthy persons, a great deal of it passes off unperceived, being dissolved or diffused in the urine. From the quantity and the regular diffusion of this mucus on the surface of the bladder, there is the greatest reason for believing that it is effused from every part of the surface; and it is a question that has not been decided whether it is discharged from glandular ducts too small to be perceived, or from the exhalent

* In some cases this mucus soon becomes putrid, and during the putrefactive process deposits a substance which appears to be calcareous.

extremities of the blood-vessels. It is probable that the use of it is to defend the internal coat of the bladder from the acrimony of the urine.

The symptoms of a stone in the bladder, as well as of several other diseases, evince that this coat is endued with a great degree of sensibility.

It is evident that the essential parts in the general structure of the bladder are the muscular coat and the internal coat last described: but in addition to this account of them, there are some other important circumstances to be noted in the description of this organ. It has been already stated, that the form of the bladder was an irregular oval, although it was somewhat varied in different persons.* The oval form is not much altered at the part called the neck of the bladder, where the urethra passes off from it. The orifice of the urethra is situated *anteriorly* at the lowermost part of the bladder. On the lower surface of the urethra, at its commencement, and on the bottom of the bladder, immediately connected with the urethra, is situated the *Prostate Gland*, (to be hereafter described with the organs of generation,) which is a firm body, that adheres strongly both to the bladder and urethra. This circumstance gives particular firmness and solidity to that part of the bladder. It has also been observed, that the bladder is attached firmly to the ossa pubis, at its neck, about the origin of the urethra. Each of these circumstances has an effect upon the orifice of the urethra; and when the bladder is opened, and this orifice is examined from within, it appears to be kept open by the connexion of the bladder with the prostate, and has been very justly compared to the opening of the neck of a bottle into the great cavity of that vessel.†

* In the female, the vertical diameter of the bladder is less than in the male. Its transverse diameter is greater in consequence of the greater width of the pelvis in the female.—P.

† The late M. Lieutaud, and after him the French anatomists of the present day, have described a small tubercle at the lower and posterior part of the orifice of the urethra, which resembles the uvula in form. It has not been noticed here; and M. Boyer states, that it is often scarcely perceptible. He, however, makes a

The orifices of the two ureters are at equal distances from the orifices of the urethra, and form with it the angles of a triangle. That part of the internal surface of the bladder which is within this triangular space, is more smooth than the remainder of the same surface, probably in consequence of the adhesion of the bladder to the prostate, and to other parts exterior to it.

That part of the bottom of the bladder, which is immediately behind the triangular space, is rather lower than this space; and but a small portion of cellular membrane exists between it and the rectum in males, and the vagina in females.

The upper part of the bladder is connected with the umbilicus by means of a ligament, which passes between the peritoneum and the abdominal muscles. This ligament consists of three cords. One of these, which is in the middle, arises from the coats of the bladder, and was, in the fœtus, the duct called urachus; and the other two, which are connected to the bladder, principally by cellular membrane, were originally the umbilical arteries.* The middle cord is of a light colour and fibrous structure; it is thickest at the bladder, and gradually diminishes as it approaches the umbilicus. In a few instances it has been found to be hollow. In its progress to the umbilicus it becomes more or less blended with the linea alba or the tendons of the abdominal muscles. The other cords are generally solid. After passing from the umbilicus to the bladder they continue on the sides of that viscus, and finally terminate at the hypogastric or internal iliac artery.

In the very young subject these cords are invested by distinct processes of the peritoneum, but their position is exterior to the peritoneum.

As the bladder is situated very near most of the large ramifications of the hypogastric artery in the pelvis, it receives

remark which is very worthy of attention, namely, that it is very subject to enlargement in old people, forming a tumour which impedes the discharge of urine. Sabatier has also made the same observation.

* See the accounts of these parts in the description of the Abdomen of the Fœtus.

branches from several of them; viz. from the umbilical arteries before they terminate; from the pubic; from the obturators, &c. These branches ramify in the cellular membrane exterior to the muscular coat, and also in the cellular substance between the muscular and internal coats. It has been *conjectured*, that their termination in exhalents on the surface of the bladder are remarkably numerous.

The veins correspond with the arteries; but they are very numerous on the lower and lateral parts of the bladder, and by uniting with the veins of the rectum form a remarkable plexus.

The *Lymphatic Vessels* of this organ do not appear more numerous than those of other parts. They pass on each side of the bladder in the course of its blood vessels, and unite with the larger lymphatics, and the glands which lie upon the great blood-vessels on the sides of the pelvis.

The *Nerves* of the bladder are derived both from the intercostal nerve and from the nerves of the medulla spinalis, which pass off through the sacrum; and therefore the bladder is more affected than the viscera of the abdomen, by injuries of the medulla spinalis.

The action of the muscular fibres of the bladder in expelling urine, and the effect of those fibres which are situated near the orifice of the urethra in retaining it, can be considered with more advantage after the structure of the urethra and the muscles connected with that canal have been described.

It has been stated that the internal coat of the bladder is very sensible; but it may be added, that in consequence of disease about the neck of the bladder, the natural sensibility appears most inordinately increased. When the intensity of pain which accompanies these complaints, the frequent recurrence of paroxysms, and their duration, are taken into view, there seems reason to believe that none of the painful affections of the human race exceed those which arise from certain diseases of the bladder. Happily these diseases are not very common.

The functions of the kidneys is to secrete urine, and that of the bladder to retain it, until the proper time for evacuation.

The urine may be regarded as an excrementitious fluid, which contains many substances in solution that are constantly found in it, and many others that are occasionally in it, which are taken as aliment or medicine,

and pass to the bladder with little, if any change. The odour of the rose-leaf, the colour of rhubarb, &c. are occasionally perceived in urine.

The substances constantly found in urine are numerous. The chemical account of the subject is so long that it cannot be detailed here; but the student ought to make himself acquainted with it, and he will read with great advantage Johnson's History of Animal Chemistry, vol. ii. page 363; and also Thomson's Elements of Chemistry, page 833.

CHAPTER V.

OF THE MALE ORGANS OF GENERATION.

These organs consist first of the *Testicles*, and their appendages.

2d. Of certain parts denominated the *Vesiculæ Seminales* and the *Prostate Gland*, which are situated near the commencement of the urethra, and are subservient to the purposes of generation.

3d. Of the *Penis*.

Of the Testicles and their Appendages.

The *Testicles* are two bodies of a flattened oval form. Each of them has a protuberance on its upper and posterior part called *Epididymis*, and is connected to parts within the cavity of the abdomen by a thick cord, which proceeds through the abdominal ring. Each testicle also appears to be contained in a sac, which is suspended by this cord and covered by the common integuments.

—The testicle of the right side is usually suspended a little higher and is frequently larger than that of the left. They attain their fullest developement in middle life, when they are an inch and a half long, an inch wide and three quarters of an inch in thickness. In old age they are shrunken in size, from the fluids being attracted to it in less quantity in consequence of the impaired sensibility of the organ. The upper extremity of each testicle has a slight inclination forwards, which is greatly increased in preparing it for demonstration by breaking up its posterior attachments.

—The coverings of the testicles are formed from without inwards, of five tunics. 1. The *Scrotum*. 2. The *dartos muscle*. 3. The

tunica vaginalis communis, so called from its covering in closely both the cord and testicle of each side, and sometimes *tunica elythroides*, from the cremaster muscles which is spread over it. 4. Of the *tunica serosa* or tunica vaginalis testis—and 5. Of the *tunica albuginea*, or proper coat of the testicle.—

That portion of the common integuments which forms the external covering of the testicles, is denominated,

The Scrotum.

The skin of the scrotum, although it is very often in a state of corrugation, has the same structure with that on other parts of the body, except that it is rather thinner and more delicate. The superior delicacy of this portion of the skin is evinced by the great irritation produced by the application of stimulating substances, and the desquamation of the cuticle, which seems to be the effect of irritation. There are many sebaceous follicles in this portion of skin; and after puberty there are often a few long hairs growing out of it, the bulbs of which are often very conspicuous. There is a small raised line in the middle of this skin, which commences at the root of the penis, and proceeds backwards, dividing it into two equal parts: this line is denominated *Raphe.*

The corrugation which so often takes place in the skin of the scrotum, appears to be occasioned by the contraction of certain fibres, which are in the cellular substance immediately within it. This cellular substance appears to be attached in a particular way to the skin; and it also invests each testicle in such a manner, that when they are withdrawn, a cavity is left in it. It has long been observed, that no adipose matter is found in this cellular substance: but it is often distended with water in hydropic diseases. As the contraction and corrugation of the scrotum has been imputed to this substance, it has been examined with particular attention by anatomists, and very different sentiments have been entertained respecting it. While some dissectors have asserted that muscular fibres could be seen in it, which they have denominated the *Dartos Muscle;* others have said that this

substance was simply cellular, and without any muscular fibres. This difference of sentiment may possibly have arisen from the different conditions of this part in different subjects; for in some cases there are appearances which seem to justify the assertion that muscular fibres exist in this structure.

After the testicles are removed, so as to leave the cellular substance, connected with the skin, if the scrotum be inverted, and this substance examined in a strong light, many fibres will appear superadded to the common cellular structure; and sometimes their colour can be distinguished to be red. It is not asserted that this will be uniformly the case; but certainly it has often been observed in this way.

The existence of an organ which possesses the power of contraction, within the skin of the scrotum and connected to it, is evinced by the corrugation which takes place when the scrotum is suddenly exposed to cold, after having been very warm. This corrugation occurs in a very sudden and rapid manner, in some cases, in which the wounded scrotum is thus exposed for the purpose of dressing: for example, upon removing an emollient poultice from this part some days after the operation for the cure of hydrops testis, by incision, if the air of the chamber be cool, a motion of the scrotum will take place, almost equal to the peristaltic movements of the intestines.

The *Arteries* of the scrotum are derived from two sources. One or two small arteries, which arise from the femoral artery, between Poupart's ligament and the origin of the profunda, are spent upon it. These are called the external pudic arteries. It also receives some small branches from the internal pudic artery.

The *Nerves* of the scrotum are principally derived from the lumbar nerves.

The Dartos,

—Considered as a muscle, arises on each side from the rami of the pubis and ischium, and passes down to the raphe of the scrotum, to which it is closely united. It is there reflected up in juxtaposition with its fellow of the opposite side, so as to form the *septum scroti*, and leave a pouch on each side for

the lodgement of the testicles, cords, and three inner tunics, and is finally inserted upon the lower portion of the corpus spongiosum urethræ. Meckel has suggested that the tissue of the dartos forms the transition between cellular tissue and muscular fibre, and that there exists between it and the other muscles of the body, the same relation as exists between the muscles of the superior and inferior animals; in the latter of which the fibrous structure is but feebly developed.

—The researches of Chaussier, Lobstein, and Breschet, seem to indicate that the dartos does not exist in the scrotum, before the descent of the testicle, and that it is formed by the expansion of the gubernaculum testis.—

The Spermatic Cord.

The cord which proceeds to the testicle, through the abdominal ring, appears at first view like a bundle of muscular fibres; but it consists of an artery and veins with many lymphatic vessels and nerves, and also the excretory duct of the testicle, connected to each other by cellular substance, and covered by an expansion of muscular fibres, which are derived from the lower edge of the internal oblique muscle of the abdomen, and continue from it to the upper part of the testicle. These fibres constitute the *Cremaster Muscle.*

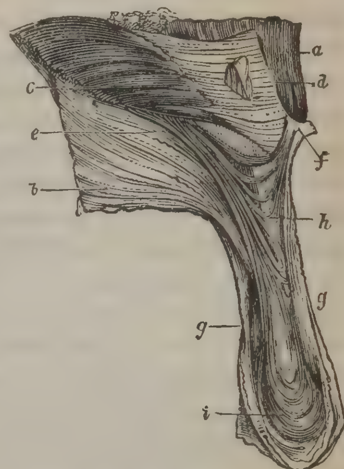
—This cellular substance which encloses both the cord and testicle, with the cremaster muscle (elythroid tunic) on its outer face, forms the *tunica vaginalis communis.* It is a thin layer, and serves to connect the dartos, to the tunica serosa, within.

—The cremaster* muscle, is formed by an arched arrangement of the fibres of the internal oblique and transversalis muscles of the abdomen, according to the observations of J. Cloquet, made upon a considerable number of fœtuses, before, during, and after the descent of the testes. The fibres originally passed from Poupart's ligament to the pubis, nearly in a straight direction; the testicle as it descended through its canal to the scrotum, pushed these fibres before it and formed them into arches or

* From Χρεμαω, suspendo.—P.

loops, which increased gradually in length, partly by distention and partly by interstitial growth, as the testicle proceeded in its descent. Hence when it is described as a distinct muscle, its origin and insertion are the same as that of the fibres. It arises from Poupart's ligament, passes down on the outer side of the tunica vaginalis communis of the cord and testicle, and passes up on the inner side to be inserted into the pubis. It gives a complete reddish colouring to these parts, called *tunica elythroida.*†

*Fig. 59.**



—Its redness disappears in emaciated or dropsical subjects, and in cases of hernia the distention causes it to separate apparently into two bundles of fibres, internal and external.

—Its action is to draw the testicle upwards and support it: it is distinct from that of the dartos.

—Fig. 59, from Sir A. Cooper's work on the testis, is a good illustration of its structure.—

The artery above mentioned is called the *Spermatic*. It commonly arises from the front of the aorta, very near its fellow, at a small distance below the emulgents, and is not much larger than a crow's quill. It proceeds downwards behind the peritoneum and before the psoas muscle, and ureter.—While it is in contact with the psoas muscle, it joins the ramifications of

* Fig. 59. *a*, Rectus abdominis. *b*, Superficial fascia of the cord. *c*, Internal oblique. *d*, Tendon of external oblique. *e*, Descending fibres of internal oblique, or origin of cremaster muscle from Poupart's ligament. *f*, Insertion of cremaster muscle on the pubis. *g*, *g*, Descending and ascending fibres. *h*, The loops which are produced in the cremaster by the descent of the testicle. *i*, Testis, covered by the tunica vaginalis to which is attached, by a sort of insertion, the loops of the cremaster.—P.

† From Ελυτρον, a sheath.—P.

the vein. It afterwards meets the vas deferens, and proceeds through the abdominal ring to the back part of the testis. Before it arrives at the testis, it divides into several branches, two of which generally go to the epididymis, and the others penetrate the tunica albuginea on the upper and back of the testicle, and ramify very minutely on the fine membranous partitions which exist on that body.

In addition to the spermatic artery, there is a small twig from the umbilical branch of the hypogastric, which passes to the spermatic cord along the vas deferens.

The branches of the spermatic vein are much larger than those of the artery: several of them proceed from the testicle so as to correspond with the arterial branches; and in addition to these there are many smaller, which also arise from the testicle and epididymis. In their course up the cord they ramify, and again unite so as to form a considerable plexus, which is called the *Corpus Pampiniforme*, and constitutes a considerable part of the volume of the spermatic cord.

As they proceed upwards, they unite into a few larger veins; and finally, on the psoas muscle, they generally form one trunk, which continues upwards so as to unite with the vena cava on the right side, and the emulgent vein on the left.

Sometimes, but not often, there are several spermatic veins on each side.

The *Lymphatic Vessels* of the testicle are very numerous, considering the size of the organ. Six or eight, and sometimes more, large trunks have been injected, running upon the córd, and continuing to the glands on the back part of the abdomen.

The *Nerves* of the testicle are derived from those which supply the viscera of the abdomen, and are to be found in the cord, although they can scarcely be traced to the testicle. A small plexus, called the spermatic, is formed by fibres from the renal plexus, and from the sympathetic nerve. These fibres accompany the spermatic vessels, and in all probability enter the body of the testis and the epididymis. The spermatic cord and cremaster muscle receive filaments from the second lumbar nerve.

In addition to these vessels, the *Vas Deferens*, which is much

firmer than either of them, is always to be distinguished in the back part of the cord.

They are all covered in front and on the sides by the cremaster muscle, which passes with them from the lower margin of the internal oblique, through the abdominal ring, and continues to the upper part of the external coat of the testicle, which is a sac apparently containing that organ, and upon this sac it is spread out and terminates.

The Tunica Vaginalis.

The *External Coat* of the testicle, which is commonly called the *Tunica Vaginalis,* is a complete sac which encloses the testicle as the pericardium encloses the heart. It covers the body of the testicle and epididymis, and adheres closely to them. It is then reflected from them so as to form a loose sac, (*Tunica Vaginalis Reflexa,*) which appears to contain them. The cavity of the tunica vaginalis commonly extends above the body of the testis up the cord, and is oval or pyriform.—This sac is so reflected from the body of the testicle that there is a place on the upper and back part of that body, at which the blood-vessels enter it, without penetrating the sac.

It resembles the peritoneum and other serous membranes in texture, and is therefore thin and delicate. It always contains a quantity of moisture, sufficient to lubricate the surface which it forms.

When the tunica vaginalis is laid open, the testicle appears as if it were contained in the posterior part of its cavity.

The testicles, as has been already stated, are of a flattened oval form. Their position is somewhat oblique, so that their upper extremities look upwards and forwards, their lower extremities downwards and backwards, and their edges present forwards and backwards.

The body of the testicle is very firm, in consequence of its enclosure in a very firm coat called *Tunica Albuginea.* Upon the upper and posterior part of it is the protuberant substance, called *Epididymis,* which is less firm, being exterior to the tunica albuginea. The blood-vessels of the testicle pass into it on the posterior edge, at some distance below the upper end.

The Tunica Albuginea,

In which the body of the testicle is commonly enclosed, is firm and dense; and upon this coat its particular form depends. It is of a whitish colour, and has a smooth external surface. It is thick as well as strong. The epididymis is exterior to it. It is only perforated by the blood-vessels, lymphatics and nerves, and by the vasa efferentia, which carry out the secretion of the testis. One portion of the tunica vaginalis adheres very closely to it, and the other appears to contain it. The portion which adheres to it is with difficulty separated, but it is a distinct membrane.

—The tunica albuginea is a fibrous membrane, considerably thinner than the sclerotic coat of the eye. It is very strong and resisting, and is susceptible of very considerable distention, when the dilating cause acts slowly, as in the engorgements of the testicles called hernia humoralis. It is also endowed with retractile properties, as is seen when the distending cause has ceased to act. Its internal surface, which is immediately applied upon the substance of the gland, gives origin to a great number of flattened filaments or septæ, which divide the gland into compartments for the separate lobules, and upon which the blood-vessels run, to be distributed in the glandular tissue. These septæ are directed to the back part of the organ necessarily, as that is the direction in which the efferent ducts of the testis pass, and form by their accumulation that thickened, oblong, fibrous mass, called the corpus highmorianum.—

The Epididymis

Differs in colour from the testicle, being more or less reddish. It commences at the upper and anterior extremity of the testicle, and passes down the posterior edge to the lower end.

At the commencement the epididymis is somewhat rounded in form, and its upper part, or head, has been called the globus major: as it descends it lessens, and about the middle of the testicle it is flattish.

It is firmly attached to the body of the testicle, at the upper

end, where the vasa efferentia pass to it; and it is also attached to it below; but at the middle it appears nearly detached from it. It has therefore been compared to an arch resting with its two extremities on the back of the testis; it is, however, in contact with it at its middle; but about the middle it only adheres by one of its edges to the body of the testis, and generally by its internal edge. It has a coat which is less firm than the tunica albuginea of the testicle, described on the last page. The tunica vaginalis of the testicle is so reflected as to cover a great part of the epididymis which is not in contact with the testicle, and also those surfaces of the epididymis and testis which are in contact with each other and do not adhere.

The Body of the Testicle.

When the tunica albuginea is cut through, and the substance of the testicle examined, it appears to consist of a soft pulpy substance of convoluted threads, of a yellowish brown colour, which is divided into separate portions by very delicate septa, attached to the internal surface of the tunica albuginea at the posterior part of the testicle. After maceration, by using a fine needle, to detach them from the cellular substance, these threads may be drawn out to a great length. In some animals they are larger than in the human species; in them, it is said, they are evidently hollow, and that very small blood-vessels appear in their coats. When mercury is injected into the vas deferens, or excretory duct of the testis, in a retrograde course, it can be perceived in these ducts in the human subject.

These delicate septa, or partitions, are united to the internal surface of the tunica albuginea at the posterior part of the testicle, at which place there is a body called *Corpus Highmorianum*, which has been regarded very differently by different anatomists. It is a long whitish substance, which extends lengthwise on the posterior part of the testis; and was supposed by Haller to resemble one of the salivary ducts. It is now, however, generally agreed to be of a cellular structure, and to contain and support the ducts which pass from the substance of the testicle to the epididymis.

The blood-vessels pass into the body of the testicle upon these septa, and are continued from them to the filaments or tubes of which the body of the testicle consists. As in some animals blood-vessels are distinguished on these tubes, there is the greatest reason to believe that a direct communication subsists between them, without the intervention of any other structure, no other structure having been discovered: but at the same time it ought to be observed, that these tubes have not yet been injected from the blood-vessels. Some ingenious anatomists have injected the artery going to the testicle so successfully that the injection has passed from it into the veins coming out of the testicle; but it is not now said by any of them, that they have filled the tubes in this manner.

Mercury will pass into these vessels from the excretory duct of the testicle; and by means of an injection in that way, the structure of the testicle can be unravelled.

This structure is as follows: the cavity formed by the tunica albuginea is divided into a number of apartments by the very thin septa or partitions above mentioned. The filamentary or tubular matter which fills each of these chambers, consists of a seminiferous duct convoluted so as to form a lobule. Three hundred of these, according to Monro, may be counted in each testicle: from each one proceeds a number of small tubes or vessels, which observe a straight course: they are, therefore, called *Vasa Recta.* These vasa recta unite with each other and form a net-work on the back of the testis, within the tunica albuginea, which is called *Rete Testis.* From this net-work other vessels, from twelve to eighteen in number, denominated *Vasa Efferentia*, proceed through the albuginea to the epididymis. These vessels are convoluted in such a manner as to form bundles of a conical form, which are called *Coni Vasculosi.* The number of these corresponds with the number of the vasa efferentia, and they compose about one-third of the epididymis, viz. all the upper part of it. The single tubes which form each of these cones, successively unite into one duct, which is convoluted so as to form all the remainder of the epididymis and is turned upwards on the back of the testicle; the tube gradually enlarges and is less con-

voluted, and finally becomes straight: it then takes the name of *Vas Deferens*, and continues on the back of the testicle and at the inner side of the epididymis to the spermatic cord.*†

A small solitary vessel or duct, has been observed by Haller, Monro, and several other anatomists, to proceed from the upper part of the epididymis: sometimes it unites to the epididymis below, and sometimes it proceeds upwards. The nature of this vessel has not been ascertained with certainty.

—Monro and Lauth, have both endeavoured to estimate the length of the seminiferous ducts. This, however, could not be done directly, in consequence of the fragility of the ducts. Their estimate is founded partly on measurement, and partly on calculation, and can only be considered an approximation to the truth; that of Monro exceeds that of Lauth. According to the former, there are three hundred lobules, each one consisting of a single seminiferous duct, arranged in the lobules in a series of close serpentine doublings, which are held together by some delicate cellular tissue. When this cellular tissue is destroyed by maceration, for a short time, each duct may be drawn out with ease, and resembles the unravelled thread of a stocking. The diameter of each duct is $\frac{1}{200}$th part of an inch, and its length a little short of seventeen and a half feet. The aggregate length of the whole will be, according to the same writer, about 5208 feet, or a little less than a mile. In the rete testis, these ducts anasto-

* De Graff appears to have been the first anatomist who made much progress in the successful investigation of the structure of the testicle; and Haller ought to be mentioned next to him, on account of the plate exhibiting this structure, and the explanation of it, which he published in the Philosophical Transactions of London, for 1749. This plate has been republished by the second Monro, in the Literary and Physical Essays of Edinburgh, and also in his Inaugural Thesis. Haller has likewise republished it in his Opera Minora. It represents not only the vasa efferentia, and the cones formed by their convolutions, but also the rete testis, and the vasa recta. Haller could inject no farther than this; but Monro and Hunter soon after succeeded so as to fill a considerable portion of the body of the testicle with mercury, injected by the vas deferens.

† In Mr. Charles Bell's Anatomical Collection in London, there is a preparation by his assistant, Mr. Shaw, in which the tubuli testis are completely injected with quicksilver and unravelled. I saw also in Leyden, one nearly as successfully executed by Professor Sandifort.—H.

mose very freely together, for the purpose, according to Lauth, of more highly assimilating the fluid they carry, by exposing it to a more extensive surface of living tissue. The length of each efferent duct, with its conus vasculosus, he has found from seven to eight feet. The length of the convoluted duct forming the remainder of the epididymis, he has seen to vary in different individuals, from sixteen to twenty-nine feet: Monro estimates it at thirty-one. There are but few instances, it appears, in which anatomists have succeeded completely in filling the tubuli testis with quicksilver, from the vas deferens. Hunter is said to have succeeded admirably in a preparation, which he sent as a present, to Catherine the second of Russia. Success in the preparation of this part, is dependent more upon perseverance and good fortune, than anatomical skill. It is useless, however, to make the effort except upon a healthy gland, taken from a subject who has died of some wasting disease, in which excitement in the organ has so long ceased, as to leave no obstructing fluid in the ducts. I have now in my cabinet, a preparation, in which I succeeded a few years ago, in filling to all appearance the whole of the tubular structure of the testicle. —According to Vauquelin, the semen masculinum consists chemically, of water 0.90; animal mucus 0.06; phosphate of lime 0.03; soda 0.01.—

Fig. 60.*

The Vas Deferens

Is a very firm tube, about one line in diameter, which is not perfectly cylindrical exteriorly, although the cavity formed by it is so. This cavity is so small in diameter, that it will only admit a fine bristle. The coats of the duct have, of course, a considerable thickness. The internal coat forms a soft surface, analogous to that of the mucous membranes: the external is

* *a*, Tubuli seminiferi, greatly magnified. *b*, Mode of anastomosis of these tubes. *c*, Blood-vessels ramifying on these tubes.—P.

firm, and its texture resembles that of cartilage. Owing to the small size of the cavity, the internal coat has not been separated from the external.

It passes upwards in the posterior part of the spermatic cord, and continues with it through the abdominal ring, under and exterior to the peritoneum; soon after this it leaves the cord and dips down into the cavity of the pelvis, forming a curve on the side of the bladder, and proceeding backwards, downwards, and inwards. In this course it crosses the ureter, and passes between it and the bladder. On the lower part of the bladder the two vasa deferentia approach each other so gradually that they appear to be nearly parallel. They proceed forward between the vesiculæ seminales, which are two bodies irregularly convoluted, that are placed in a converging position with respect to each other, and communicate with the vasa deferentia. The vasa deferentia finally terminate almost in contact with each other in the posterior part of the prostate where they perforate the urethra. At the distance of about two inches and a half from their termination they enlarge in diameter, and become somewhat convoluted. At the posterior margin of the prostate they come in contact with the anterior extremities of the vesiculæ seminales, and unite with them. After this union they diminish in size, and become conical; and passing a short distance through the substance of the prostate, during which they approach each other more rapidly, they penetrate the urethra, so as to open in it on each side of a small tubercle, called the *Caput Gallinaginis*, soon to be described.

Of the Vesiculæ Seminales and the Prostate Gland.

The *Vesiculæ Seminales* are two bodies of a whitish colour, and irregular form, being broad and flat at their posterior extremities, and terminating in a point at the other. They are about two inches and a half in length, and six or seven lines in diameter at their widest part. Their surfaces are so convoluted, that they have been compared to those of the brain. They are situated between the rectum and bladder, and are connected to each by cellular membrane.

When the vesiculæ seminales are laid open by an incision, they appear to consist of cells of a considerable size, irregularly arranged; but when they are carefully examined exteriorly, and the cellular membrane about them is detached and divided, they appear to be formed by a tube of rather more than two lines in diameter and four or five inches in length, which terminates, like the cæcum, in a closed extremity. From this tube proceed from ten to fifteen short branches, which are closed in the same manner. All these tubes are convoluted so as to assume the form of the vesiculæ seminales above described; and they are fixed in this convoluted state by cellular membrane, which firmly connects their different parts to each other. It is obvious that tubes thus convoluted, when cut into will exhibit the appearance of cells, as in the present instance.

This convoluted tube composing the vesiculæ seminales, terminates in a very short duct, which is nearly of the same diameter with the vas deferens; this duct joins the vas deferens so as to form an acute angle.

From the union of the vesiculæ seminales with the vas deferens on each side, a canal, which seems to be the continuation of the vas deferens, proceeds through part of the prostate to the urethra, which it perforates. These canals are from eight to twelve lines in length; they are conical in form, their largest extremity being equal to the vas deferens at that part.

If the air or any other fluid be injected through the vas deferens into the urethra, it will pass at the same time into the vesiculæ seminales, and distend them. It has been observed, that a fluid passes in this manner much more readily from the vasa deferentia into the vesiculæ seminales, than it does from these last mentioned organs into the duct.

—The union formed by the short duct of the seminal vesicle and vas deferens of each side constitutes the *ductus ejaculatorius*, which is about an inch in length, and runs in close contact and parallel with its fellow of the opposite side, between the middle and lateral lobes of the prostate, and opens obliquely into the urethra by a small oblong orifice in the caput gallinaginis. Each ejaculatory duct is a conoidal tube, its apex being at its

orifice in the urethra. Hence fluids pass so readily into the seminal vesicles, when injected along the vasa deferentia. The diminution of the duct at its urethral orifice, will also increase the force of the jet, by which the fluid of the vesicle is ejected, when spasmodically compressed by the levator ani muscle.—

These organs were generally regarded as reservoirs of semen, and analogous to the gall-bladder in their functions, until the late Mr. J. Hunter published his opinion that they were not intended to contain semen, but to secrete a peculiar mucus subservient to the purposes of generation.

He states the following facts in support of his opinion.

A fluid, very different from semen, is found after death in the vesiculæ seminales.

In persons who have lost one testicle, a considerable time before death, the vesiculæ seminales on each side are equally distended with this peculiar fluid. In the case of a person who had a deficiency of the epididymis on one side, and of the vas deferens on the other, the vesiculæ were filled with a peculiar fluid!

The sensation arising from redundance of the secretion of the testis, is referred to the testes, and not to the vesiculæ seminales.

In some animals there is no connexion between the vasa deferentia and the vesiculæ seminales.

See Observations on certain Parts of the Animal Economy, by John Hunter.

The Prostate Gland

Is situated on the under and posterior part of the neck of the bladder, so as to surround the urethra. Its form has some resemblance to that of the chestnut, but it has a notch on the basis like that of the figure of the heart on playing cards, and it is much larger than the chestnut of this part of America. The basis of this body is posterior, and its apex anterior; its position is oblique, between the rectum and the symphysis pubis. Below there is in some cases a small furrow, which, in addition to the notch above, gives to the gland an appearance of being divided into two lobes. By turning away the vesiculæ seminales and

vasa deferentia from the under surface of the bladder, we bring into view a small tubercle at the upper part of the base of the prostate, called by Sir Everard Home the third lobe. When diseased it projects into the cavity of the bladder.*

It adheres to the urethra and neck of the bladder. Its consistence is very firm and dense, resembling the induration of scirrhus rather more than the ordinary texture of glands.

This gland receives small branches from the neighbouring blood-vessels, and has no artery of considerable size exclusively appropriated to it.

As it lies in close contact with the urethra, the ducts which pass between it and the urethra are not to be seen separate from these bodies: but ducts can be seen in the substance of the gland, which perforate the urethra, and open on the sides of the caput gallinaginis to the number of five or six on each side. By pressure a small quantity of a whitish fluid can be forced from these orifices, which is rather viscid, and coagulable in alcohol.

The particular use of this fluid is not known.

Fig. 61.†

—Fig. 61, is a magnified representation of a section of the prostate gland, in order to show its vesicular structure.

—From these vesicles or modified follicles, originate many excretory canals, which unite together so as to constitute about twelve ducts, which open into the urethra by the sides of the caput gallinaginis.

—Loder asserts that there are from thirty-two to forty-four of these excretory ducts—but this is probably an error. I have sought for these ducts in several cases where they were so much enlarged from catarrhal inflammation of the bladder, as to admit the end of a small probe, without being able to detect more than the

* In a healthy state, the third lobe forms but a slight elevation in the cavity of the bladder, covered by mucous membrane, called uvula vesicæ.—P.

† Section of the prostate gland magnified.—*a*, *a*, the two lobes separated. *b*, excretory ducts.—P.

number above mentioned. The whole structure of the prostate appears to be that of a compound mucous gland, designed to throw a lubrifying mucus in great abundance into the urethra, at the spot where the urine first enters it, in its passage outwards.

—The substance of the prostate, in which these ducts and vesicles are placed, is not exactly understood. It is of a whitish appearance, very dense, distensible and yet easily lacerated. The *superior* face of the prostate, is in contact with the anterior ligaments of the bladder; its *inferior* with the rectum to which it adheres. It is overlapped by the rectum upon the sides when the latter is distended with feculent matter; *laterally* it corresponds to the levator ani muscles; by its *base*, it corresponds to the neck of the bladder; and by its *apex* or anterior extremity to the membranous portion of the urethra. Its distance from the skin of the perineum, an inch in front of the anus, varies, according to Dupuytren, from two to three inches and a half, as the subject is thin or fat.

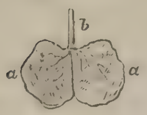
—The prostate belongs to the urethra, and not to the bladder as students generally suppose. The urethra passes through it near the centre, and that portion of it is called the prostatic portion of the urethra. The prostate gland is about twelve lines in length, measured in the middle line, and eighteen in breadth.

Cowper's Glands,

—Or, as they are sometimes called, the little prostate glands, are placed immediately behind the bulb of the urethra, between the two layers of the triangular ligament, yet to be described. Their ducts are about an inch in length, run under the mucous membrane of the urethra, and open obliquely into the canal about an inch in advance of the glands. The size of the glands is usually about that of a garden pea (see Fig. 62*); sometimes they are much larger. I have succeeded in two or

* Fig. 62, is a representation of Cowper's gland, cut open, showing its similarity of structure with the prostate gland.—P.

Fig. 62.*



three instances in distending them with mercury from their ducts. Their structure and office is the same as that of the prostate, (see Fig. 62); sometimes they appear entirely deficient. One or more small glands of a similar description, have been discovered by Littre in front of those of Cowper, called the glands of Littre, near the angle of union of the crura penis. They are rarely seen. Cowper's glands are placed within the circle formed by the ejaculator seminis muscles, the action of which will assist in discharging the mucus they secrete. In some of the inferior animals, they are vesicular, and have been mistaken for another pair of *vesiculæ seminales;* in these cases however, the parts may always be distinguished from one another; the vesiculæ seminales are distended with fluid only at the epoch of rut; Cowper's glands are always filled with an opaline starch-like mucus.—

Of the Penis.

The penis, when detached from the bladder, and the bones, to which it is connected, and divested of the skin which covers it, is an oblong body, which is rounded at one extremity and bifurcated at the other.

It is composed of three parts, namely, two oblong bodies, called *Corpora Cavernosa,* which, at their commencement, form the bifurcated portions, and then unite to compose the body of the organ; and a third part, of a spongy texture, which is connected to these bodies where they unite to each other, on the under side, and continues attached to them during the whole extent of their union, terminating in an expanded head which covers the anterior extremities of the corpora cavernosa. The urethra passes from the neck of the bladder, on the under side of the penis, to its anterior extremity, invested by this third body, which is therefore called *Corpus Spongiosum Urethræ.*

The two bifurcated extremities are attached each of them to one of the crura of the pubis and ischium; they unite to form the body of the penis immediately anterior to the symphysis pu-

* *a*, *a*, Cowper's gland divided. *b*, Excretory duct.—P.

bis, to which the lower part of it is also attached; so that the penis is firmly connected to the middle of the anterior part of the pelvis. The urethra proceeds from the neck of the bladder, between the crura of the ischium and pubis and the crura of the penis, to join the body of the penis, at its commencement, and near this place its connexion with the corpus spongiosum begins; so that there is a small portion of the urethra between the neck of the bladder and the commencement of the corpus spongiosum, which is not covered by the corpus spongiosum. This is called the membranous part of the urethra.

The penis therefore consists of two oblong bodies of a cellular structure, which originate separately, but unite together to form it; and of the urethra, which joins these bodies immediately after their union, and is invested by a spongy covering, which by its expansion forms the anterior extremity not only of the urethra, but of the whole penis. These three bodies, thus arranged and connected, are covered by cellular membrane and skin in a manner to be hereafter described.

The Corpora Cavernosa,

Which compose the body of the penis, are two irregular cylinders, that are formed by a thick dense elastic membrane, of a whitish ligamentous appearance and great firmness. They are filled with a substance of a cellular structure, which is occasionally distended with blood. The crura of these cylindrical bodies, which are attached to the crura of the ischium and pubis, are small and pointed at the commencement, and are united to the periosteum of the bones. In their progress upwards they enlarge, and at the symphysis of the pubis they unite so as to form an oblong body, which retains the appearance of a union of two cylinders applied to each other lengthways; for above, there is a superficial groove passing in that direction, which is occupied by a large vein: and below there is a much deeper groove, in which the urethra is placed. Between these grooves is a septum which divides one side of the penis from the other. It appears to proceed from the strong membrane which forms the penis, and is composed of bundles of fibres, which pass from one groove of the penis to the other, with many intervals be-

tween them, through which blood or injection passes very freely. Sometimes these bundles of fibres, with their intervals, are so regularly arranged, that they have been compared to the teeth of a comb. This septum extends from the union of the two crura to their termination.

—It is called the *Septum pectiniforme;* the internal between the bundles of dense cellular fibres, become so great and so numerous in the anterior half, that it ceases to divide the penis into two *corpora cavernosa.* Anatomists now consider the corpus cavernosum as one body imperfectly divided by the septum. It is a distinction, however, without much value.—

Each of these cylinders is penetrated by the main branch of the pudic artery, which is about equal in size to a crow's quill. These arteries enter the corpora cavernosa near their union, and continue through their whole extent, sending off branches in their course; the turgescence and erection of the penis is unquestionably produced by the blood which flows through these vessels into the penis.

The interior structure of the penis, when examined in the recent subject, is of a soft spongy nature, and seems stained with blood. If any fluid be injected through the arteries this substance appears cellular, and may be completely distended by it. When air is injected, and the structure becomes dry, the penis may be laid open; the cellular structure then appears as if formed by a number of lamina and of filaments, which proceed from one part of the internal surface of the penis to another, and form irregular cells. It has been compared to the lattice-work in the interior of bones; and it is suggested by M. Roux, that the fibres of which the structure consists resemble those of the strong elastic coat of the penis.* If these cells are filled with

* Mr. John Hunter says on this subject, "That the cells of the corpora cavernosa are muscular, although no such appearance is to be observed in men: for the penis in erection is not at all times equally distended. The penis, in a cold day, is not so large in erection as in a warm one: which probably arises from a kind of spasm, that could not act if it were not muscular.

In the horse, the parts composing the cells of the penis appear evidently muscular to the eye, and in a horse just killed, they contract upon being stimulated.—H.

coloured wax, injected by the artery, and the animal substance is then destroyed by placing the preparation in a corroding liquor, the wax which remains shows that the membranes forming the cells are very thin.

These cells communicate freely with each other; and, therefore, if a pipe be passed through the strong coat of the penis, the whole of them can be filled from it by the ordinary process of injection.

The Urethra

Is a membranous canal which extends from the neck of the bladder to the orifice at the extremity of the penis; and for a very great part of its length is invested by a spongy structure, called the corpus spongiosum urethræ. It proceeds from the neck of the bladder along the upper part of the prostate; from the prostate it continues between the crura of the penis until their junction: it then occupies the great groove formed by the corpora cavernosa on the lower side of the penis, and continues to the orifice above mentioned. At a small distance from the prostate gland the spongy substance which invests it commences, and continues to its termination. After this spongy substance has arrived at the termination of the corpora cavernosa, it expands and forms a body of a particular figure which covers the extremities of the corpora cavernosa, and is denominated the *Glans Penis.*

The *Corpus Spongiosum* begins at the distance of eight or ten lines from the anterior part of the prostate. It is much larger at its commencement than at any other part except the glans, and this enlarged part is called the *Bulb.* It surrounds the whole of the urethra, and, with the exception of the bulb and the glans penis, is of a cylindrical figure. It is formed by a membrane which has some resemblance to the coat of the penis, but is much thinner, and by a peculiar spongy substance, which occupies the space between the internal surface of this membrane and the external surface of the canal of the urethra. The membrane and the spongy substance, form a coat to the urethra, which, with the exception of the enlargement before mentioned, is about one line thick. After this spongy substance has arrived

at the termination, its coat adheres firmly to the coat of the penis.

The *Bulb*, or first enlargement of the corpus spongiosum, is oblong, and rather oval in form; it is marked by a longitudinal depression in the middle, which is very superficial. It consists entirely of the spongy substance above mentioned.

The *Glans Penis* is also composed of the same spongy substance, but the coat which covers it is more thin and delicate than that of the other parts of the urethra. The lower surface of the glans is fitted to the extremities of the corpora cavernosa, but it is broader than the corpora cavernosa, and therefore projects over them on the upper and lateral parts of the surface of the penis. The edge of the prominent part is regularly rounded, and is denominated the *Corona Glandis*.

—The contracted portion immediately behind the corona, is called the *collum* or neck.—

Several small arteries pass to this spongy structure. The pudic artery, as it passes on each side to the corpora cavernosa, sends a branch to the bulb of the urethra. The same vessel, in the substance of the penis, also sends branches to the urethra; and the artery on the back of the penis terminates in small branches, which penetrate the substance of the glans.

By these vessels blood is carried to the spongy substance of the urethra, which is occasionally distended in the same manner that the cavernous bodies of the penis are distended during the erection of that organ. But the cellular structure of this organ is not so unequivocal as that of the corpora cavernosa; for if it be injected with coloured wax, and corroded in the usual manner, the injected matter will exhibit an appearance which has the strongest resemblance to a convoluted vessel, like the vas deferens in the epididymis.*

The Canal of the Urethra,

Which conveys the urine from the bladder, is a very important

* Mr. Hunter says, "that the corpus spongiosum urethræ and glans penis are not spongy or cellular, but made up of a plexus of veins. This structure is discernible in the human subject; but is much more distinctly seen in many animals, as the horse," &c.—H.

part of the urinary organs. It consists of a vascular membrane with a smooth surface, which is perforated by the orifices of many mucous follicles, some of which are of considerable size. It is extremely sensible, and has so much power of contraction, that some persons have supposed muscular fibres to exist in its structure.

It is differently circumstanced in different parts of its course. While surrounded with the prostate it adheres firmly to that body, seeming to be supported by it; and here its diameter is larger than it is farther forward. On the lower or posterior side of this portion of the urethra, is an oblong eminence, called *Verumontanum*, or *Caput Gallinaginis*, which commences at the orifice of the urethra, and continues throughout the whole portion that is surrounded by the prostate gland, terminating at the point of that body. The posterior extremity of this tubercle begins abruptly, and soon becomes thick and large; anteriorly it gradually diminishes to a line, which is sometimes perceptible for a considerable distance in the urethra, in a straight forward direction. In the upper edge or top of this body is a groove, which is produced by a mucous follicle; on the lateral surfaces, anterior to the middle, are the orifices of the common ducts of the vesiculæ seminales, and vasa deferentia, (see page 145,) which are sufficiently large to receive a thick bristle. Near these, on each side, are five or six smaller orifices of the excretory ducts of the prostate gland. At the distance of an inch before the extremity of the bulb of the urethra, in the lining membrane, are the openings of two ducts, one on each side, that lead to small glandular bodies called Cowper's glands, which are situated on each side of the urethra below the bulb, but are covered by the acceleratores urinæ muscles.

The diameter of the urethra lessens after it leaves the prostate. That portion of the canal which is between this gland and the bulb, without investment, and therefore called the membranous part, is the smallest in diameter.

After it is invested with the spongy substance, it has a small enlargement, and then continues nearly of one size, until it arrives near the glans penis, when it again enlarges and alters its form,

being no longer cylindrical, but flattened. Its broad surfaces have now a lateral aspect.

From the bulb of the corpus spongiosum to this last enlargement, the appearance of the inner surface of the urethra is uniform. The membrane is thin and delicate, and in a healthy subject, who has been free from disease of these parts, is of a whitish colour; but blood-vessels are very perceptible in it. When it is relaxed, it appears to be thrown into longitudinal wrinkles; but it admits of considerable extension; being somewhat elastic: when extended, its surface appears smooth, as if it were covered with an epithelium. Mr. Shaw, of London, has described a set of vessels immediately below the internal membrane of the urethra, which, when empty, are very similar in appearance to muscular fibres. He says he has discovered that these vessels form an internal spongy body, which passes down to the membranous part of the urethra, and forms even a small bulb there. His preparation with a quicksilver injection of the part is certainly a very satisfactory proof of its existence.* Throughout the whole extent of this part of the urethra, are the orifices of a great many mucous ducts or sinuses, which pass obliquely backwards. Many of these are so small that they cannot be penetrated by a bristle, or probe of that size; but some are larger. It has not been observed that any glandular body immediately surrounds them, although they secrete the mucus with which the urethra is lubricated. On the lower side of the urethra, near the commencement of the glans penis, there is one or more of them, so large that their orifices sometimes admit the point of a small bougie.†

These organs when inflamed, secrete the puriform discharge which takes place in gonorrhœa.—In a natural state they produce the mucus which is constantly spread over the surface of the urethra, to defend it from the acrimony of the urine, and which passes away with that fluid unperceived.

The surface of the urethra is endued with great sensibility, and

* See Med. Chirurg. Transactions of London, vol. x.

† They were discovered by Plazzoni, of Padua, in 1621. Their number, according to Loder, amounts to about 65. See his plates.—H.

is therefore liable to great irritation from contact with any rough body or any acrid substance. Irritation, thus excited, induces a state of contraction, which is particularly remarkable, as no muscular fibres are to be seen in its structure. When a bougie has been passed into the urethra for a considerable distance, if it cannot proceed the whole way, it sometimes happens that the instrument will be discharged by a steady uniform motion, which seems to proceed from a progressive contraction of the urethra, beginning very low down. At particular times, after the urethra has been much irritated, it will not receive a bougie, although at other times a bougie of equal size may be passed to the bladder without opposition. This cannot depend upon that elasticity which was noticed before.*

Upon the two crura of the penis, or the beginning of the corpora cavernosa, are fixed the muscles called *Erectores Penis*, which are described in the first volume.† These muscles cover the crura of the penis from their origin to the junction, and not only compress them, but also influence the motion of the penis when it is distended.

The bulb of the urethra is covered by a muscular coat, called the *Accelerator Urinæ*, which has the effect of driving forwards any fluid contained in the cavity of the urethra, and also of giving the same direction to the blood in that part of the corpus spongiosum. There is also the *Transversus Perinei* on each side, that passes transversely from the tuberosity of the ischium to the bulb of the urethra.—Finally, the lower part of the sphincter ani muscle, which is nearly elliptical in form, is inserted by its anterior point into the muscular covering of the bulb of the urethra. Upon removing the integuments, these muscles are in view; and the course of the urethra from the bladder is concealed, particularly by the anterior point of the sphincter ani. When the sphincter ani is dissected away from its anterior con-

* Sir Everard Home, whose professional opinions are of great weight, has lately described in the Transactions of the Royal Society, the appearance of the lining membrane of the urethra, when viewed through a microscope of great powers. From this paper, it seems that he is fully convinced of its muscular structure.—H.

† See description of "Muscles about the Male Organs of Generation," vol. 1, page 306.

nexions, and the cellular and adipose substance, which is sometimes very abundant, is also removed, the lower surface of the membranous part of the urethra may be brought into view, as it proceeds from the prostate gland to the bulb of the corpus spongiosum.*

When the accelerator urinæ is removed from the bulb of the urethra, there will appear two bodies, which have some resemblance to flattened peas. They lie one on each side of the urethra, in contact or nearly so with its bulb, and from each gland proceeds an excretory duct of an inch and a quarter in length between the corpus spongiosum and the lining membrane of the canal of the urethra, and opens into the latter. Its orifice is found with some difficulty, but is large enough to admit a bristle. These are Cowper's glands.†

The penis is connected to the symphysis pubis by a ligamentous substance, which proceeds from the back or upper surface of the organ to the anterior part of the symphysis, and connects these parts firmly to each other, called *ligamentum suspensorium penis.*

Thus constructed, of the corpora cavernosa and the urethra with its corpus spongiosum, and attached to the pelvis as above mentioned, the penis is invested with its integuments in the following manner.

—The entire length of the urethral canal from its commencement at the back part of the prostate gland, that is at the neck of the bladder, to its external orifice in the glans penis, varies in different subjects when distended or gently drawn out, from eight to ten inches. The difference in length in different individuals is found to depend upon the greater or less developement of the

* The natural situation of the membranous part of the urethra, and of the prostate gland, as well as their relative position with respect to the sphincter ani, rectum, &c. can be best studied by a lateral view of the contents of the pelvis; which is to be obtained by removing carefully one of the ossa innominata, and dissecting the parts which were enclosed by it.

† These glands were discovered by Mery, in 1684, and described by Cowper, in 1699. A third gland, smaller than the preceding, connected with the curve of the urethra under the symphysis pubis, was discovered by Cowper, and Morgagni speaks of having observed a fourth.—H.

penis from the bulb of the urethra outwards; the length of the membranous and prostatic portions being nearly the same in all adult subjects. The membranous portion of the urethra extends from the bulb to the anterior margin of the prostate, and is about three quarters of an inch long; it is rather longer on its upper than its lower surface, in consequence of the extension of the pendulous portion of the bulb backwards. In place of the spongy portion, it is covered on its outer surface with a thin layer of pale cellulo-muscular fibres like that forming the neck of the bladder (see page 125,) with which it is continuous.*

—The prostatic portion of the canal is of the length of the gland, and varies from fifteen to eighteen lines. It is conoidal in its shape, the base of the cone being on the side of the bladder, and its narrowest part or apex continuous with the membranous portion. In consequence of this shape, small calculi frequently drop into it from the bladder, and sometimes imbed themselves in the substance of the prostate gland. The direction of the prostatic and membranous portions of the urethra is from above downwards and backwards, towards the neck of the bladder, forming a curve, the concavity of which is towards the pubis. The spongy or external portion of the canal forms a curve in the opposite direction, so that the whole canal in its undistended state, resembles somewhat in shape the italic *S*. When the penis is drawn upwards and forwards, both curves as Amusat has

* Wilson has described a muscle, (see vol. 1, p. 307,) situated one upon each side of the membranous portion of the urethra, called the musculus constrictor urethræ or pubo-urethralis. It is oblong, quadrilateral, and flattened from without inwards. It arises from a short tendon on the back part of the pubis, near the symphysis. It increases in size as it descends, embraces closely the membranous portion of the urethra, and at the lower surface of the latter is closely connected with its fellow of the opposite side; so that the two form as it were a muscular ring around the urethra. In front it is usually connected with the posterior part of the accelerator urinæ muscle, and below it is connected to the levator ani. It appears to me to form a part of the latter muscle, and to act as a constrictor of the urethra to the male and of the vagina in the female. These are voluntary muscles, according to Müller, and are the principal agents by which we exercise any voluntary control over the discharge of urine.

When spasmodically contracted, they compress the urethra, and often render the passing of a catheter along this portion of the canal impossible, till the spasm is relaxed by medicinal means.—P.

shown, are *nearly* effaced, and a straight instrument may, with facility, be passed into the bladder.—

Integuments of the Penis.

The glans penis, the structure of which has been already described, is covered by a continuation of the skin which appears altered in its texture so as to resemble in some respects the skin of the lips, and in like manner is covered by a delicate production of cuticle.

Around the corona of the glans, especially on its upper part, there are whitish tubercles, *glandulæ Tysonii*, which are of different sizes in different persons, but always very small. The skin adheres firmly to the whole extent of the corona of the glans, and is very delicate in its structure, as it continues from the glans upon the body of the penis; but it gradually changes so as to assume the appearance and structure of a common skin, and continues in this state over the penis. The adhesion of the skin to the ligamentous coat of the corpora cavernosa also becomes more loose, owing to the quantity and texture of the cellular substance which connects them. The skin, thus connected to the penis, has commonly more length than that organ, even in its extended state. In consequence of this greater length, and of its adhering firmly around the corona glandis, it necessarily forms a circular fold or plait, which varies in size according to the length of the skin. This fold is generally situated at the commencement of the firm attachment of the skin to the body of the penis, or around the glans; but it may be formed any where upon the body of the penis by artificial management.

This duplicature, or fold of the skin, when it takes place so as to cover the glans, is called the *Prepuce;* and the skin, which is very tender and delicate for some distance from the glans, forms that surface of the prepuce which is in contact with the glans when it covers that body.

There is also a small fold of the skin, which is longitudinal in its direction, that commences at the orifice of the urethra, and extends backwards on the lower surface of the penis. It is unvarying in its position, and is called *Frenum.*

It is a general observation, that adeps is not found in the cellular substance which connects the skin to the body of the penis; but this cellular substance is distended with water in some hydropic cases.

From the glands of Tyson, and from small follicles on each side of the frænum, is secreted an unctuous fluid, (*Smegma preputii*,) which, when allowed to continue, becomes inspissated, and acquires a caseous consistence and colour, as well as a peculiar odour. It sometimes also acquires an acrimony which produces inflammation on the surface with which it is in contact, as well as the copious secretion of a puriform fluid.

The distribution of the pudic artery in the penis has already been mentioned; and a farther account of its origin and progress to its destination, will be found in the general account of the arteries. Sometimes small branches of the external pudic arteries, which originate from the femoral, are extended to the penis; and it has been asserted, that branches of the middle hæmorrhoidal artery have also been found there, but this does not often occur.

The *Veins* of the penis are of two kinds; those which originate in the corpora cavernosa, accompany the corresponding branches of the pudic artery, but communicate more or less with the plexus of veins on the lower and lateral part of the bladder. There is also a great vein, which occupies the groove on the back of the penis, between the corpora cavernosa, that appears particularly appropriated to the corpus spongiosum urethra; for it originates in the glans penis, and receives branches from the urethra as it proceeds backwards. There are often two of these veins, one in the groove, and the other more superficial: they generally unite near the root of the penis. The common trunk then passes between the body of the penis and the symphysis pubis, and terminates in a plexus of veins at the neck of the bladder, which is connected to the plexus above mentioned on the lower and lateral parts of the same viscus.

The *Absorbent Vessels* of the penis take two different directions on each side. Those which arise from the integuments generally, unite so as to form a few trunks on the back of the

penis, which divide near the root of the organ, and proceed to the glands of the groin. Those which originate from the interior parts of the penis, accompany the blood-vessels, and terminate in the plexus of lymphatics in the pelvis.

It ought to be noted, that the superficial lymphatics *generally* enter the *upper* inguinal glands. —The deep-seated lymphatics, which originate in the glans penis and the cavernous structure, run with the cavernous artery of the penis, directly into the pelvis. Hence in chancres of the glans, the venereal poison may be introduced into the system without traversing the glands of the groin.—

The *Nerves* of the penis are principally derived from the lower sacral nerves, which unite in the plexus that forms the great ischiatic. From these nerves a branch on each side originates, which passes, like the pudic artery, between the sacro-sciatic ligaments. In this course it divides into two branches, one of which passes below to the muscles of the penis and urethra, and to the contiguous parts; and some of its branches seem finally to terminate in the dartos: the other branch proceeds along the crura of the pubis and ischium, and passing between the symphysis pubis and the body of the penis, arrives at the upper surface or dorsum of the penis, along which it continues on the outside of the veins to the glans, in which it terminates. In this course it sends off several branches, some of which terminate in the integuments of the penis.

Fascia of the Perineum.

[There are several fasciæ and ligaments about the perineum, which should be connected with the account of its viscera. Immediately beneath the skin of the perineum is the Perineal Fascia, a thin but strong membrane, which extends from bone to bone, occupying the space between the anus and the posterior part of the scrotum. It is rather better seen in lean subjects than in fat ones, for in the latter it is converted in part into adipose membrane. When a rupture occurs in the posterior part of the urethra, this fascia prevents the urine from showing itself imme-

diately in the perineum, and drives it into the cellular structure of the scrotum.

Immediately beneath the perineal fascia are placed the muscles; when they are removed, the bulb of the urethra may be seen very advantageously, extending in the middle of the perineum almost to the anus. It is not loose and pendulous, but is attached by its pelvic surface to the triangular ligament of the urethra. This ligament is a septum between the perineum and the pelvis, and connects itself to the pelvic or internal edges of the rami of the pubis and ischi as far down as the organs of the crura penis. It extends from the arch of the pubis to the line mentioned, and fills up all the space between the bones of the opposite sides. It consists of two lamina, and Cowper's glands are placed between them. About an inch below the symphysis pubis a perforation is made in this ligament for the passage of the membranous part of the urethra.

Just below the symphysis pubis, between the two lamina of the triangular ligament, is placed a much stronger ligament called the pubic, which is about half an inch broad; its lower edge is thick and rounded.]*

After an examination of the relative situation of the muscles and blood-vessels of the male organs of generation, there appears reason to doubt, whether the erection of the penis can be referred to pressure upon the veins which return from that organ. Albinus has written on this subject. See Academicarum Annotationum, lib. ii. caput xviii. Haller has also considered it, and stated the opinions of several anatomists, in his Elementa Physiologiæ, tom. vii. page 555.

The manner in which the urine is confined in the bladder does not appear to be clearly understood. The connexion of the neck of the bladder with the prostate, and the appearance of the contiguous parts of the bladder, do not render it probable that these parts act like a sphincter. The late J. Hunter, who paid great attention to the functions of these organs, was very decided in his opinion that the contraction of the urethra produced the effect of a sphincter of the bladder. He has published some very ingenious observations respecting the manner in which urine is discharged from the bladder, in his Treatise on the Venereal Disease, part iii. chapter ix.

* For farther detail on the subject of the fasciæ of the pelvis, see Lessons in Practical Anatomy, by Dr. Horner.

Mr. Hunter also long since asserted, that the vascular convoluted appearance of the corpus spongiosum urethræ was more distinct in the horse than the man. In the fifth volume of Leçon's d'Anatomie Comparée of Cuvier, the very learned and ingenious author confirms the declaration of Hunter, respecting the vascular convolutions of the corpus spongiosum of the horse. He states, that the corpora cavernosa of the penis of the elephant appear to be filled in a great degree with the ramifications of veins, which communicate with each other by such large and frequent anastomoses, that they have a cellular appearance. A similar structure exists in the horse, camel, bullock, deer, &c.; and in them all these communicating branches can be distinguished from those which extend the whole length of the penis.

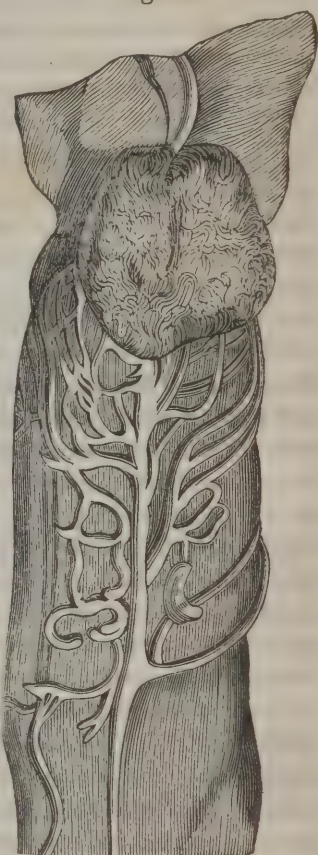
The corpus spongiosum urethræ, according to M. Cuvier, is constructed in a similar manner. From these facts he is induced to believe that this structure pervades the whole class of mammalia.

General Anatomy of Erectile Tissue.

—The term *erectile tissue, tela erectilis,* was first adopted by Dupuytren and Rullier, to indicate various parts which are principally composed of blood-vessels, intimately interwoven with nerves, and which, under various causes of excitement, mechanical or sensorial, are rendered turgid and prominent, or thrown into a state of erection by a sudden influx of blood. This system includes the corpus cavernosum penis, corpus spongiosum urethræ, clitoris, nymphæ, plexus retiformis vaginæ, nipples, cutaneous papillæ, mucous villi, red borders of the lips, and, according to Harrison, the seminal tubercle or caput gallinaginis. It is supposed by some to exist in the iris, and Beclard is disposed to include in this tissue the spleen. It is seen also in other positions in the inferior animals, as in the wattles of the turkey, and tongue of the chameleon. It is developed also accidentally in different parts of the body, as in erectile tumours, (aneurisms from anastomosis,) and in fungus hæmatodes. In some of the organs it is enclosed in a fibrous sheath, which limits the extent of the expansion and determines its form. Its developement, however, is found more perfect in some organs than the rest, and it is most so in the corpus cavernosum penis, and corpus spongiosum urethræ. In these parts it has principally been made the subject of investigation. The commonly received opinion, and which

is kept up by the appearance which anatomical preparations present, when the common cellular tissue of the parts is filled with wax, to exhibit their general form, is this; that the erectile tissue consists of loose elastic tissue divided into innumerable cells, into which, during erection, blood is poured by the arteries and taken up subsequently by the veins. Such was the opinion of Ruysch, Haller, and Bichat. Vesalius, Mascagni and Hunter, were of the opinion that the tissue was made up of a multitude of arteries and veins, the latter predominating greatly in number, closely interwoven, and resting upon the cells;* which are formed by processes sent inwards from the general investing sheath of the parts (involucrum) which divide the interior into cells, like the septæ which divide the cavity of an orange, and which form a sort of scaffolding for the support of the vessels. This opinion has been supported by Cuvier, Tiedemann, Beclard and Weber, who assert that a structure corresponding to it is discernible in man, and is particularly obvious in the horse and other large animals. The annexed cut from Moreschi, shows the congeries of vessels as they exist in the injected state in the glans penis, which are principally veins, and are characterized by their number, tenuity and softness, and which empty into the superficial veins of the penis.

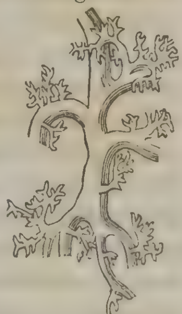
Fig. 63.



* See Erectile Tissue, Dict. Des Sciences Medicales, by Dupuytren and Rullier.—P.

—Professor Müller has recently discovered in the structure of the corpus cavernosum penis, two sets of arteries forming ramifications from the common trunk; the *arteria profunda.* One of these consists of the ordinary nutritious arteries of the part, which ramify over the cells and terminate in the capillary veins, and through which, in the unexcited state, all the blood flows that is conveyed by the profunda. The other sets he calls the *arteriæ helicinæ,* see Fig. 64, which is a magnified representation of a part of the profunda with its helicine branches, so named from their resemblance to the tendrils of the vine; they are much shorter, however, in proportion to their thickness, than the comparison would seem to indicate. These arterie become dilated during the state of erection, and receive all the blood imported by the profunda, in increased quantities during the period of excitement. These arteries may be seen with the lens or even with the naked eye, in the back part of the corpus cavernosum penis, when the profunda has been injected with coloured size, the corpus cavernosum subsequently slit open, and all the injection which has escaped into the cells, carefully washed away. These branches from the profunda are short, being about a line in length and a fifth of a millimetre* in diameter, and are of the same size whether they are derived from the larger branches or the finest twigs.

Fig. 64.



—The arteriæ helicinæ, sometimes branch off singly, sometimes in little bundles from three to ten in number; in which case they originate by a common trunk. They project constantly into the cells of the spongy substance, which Muller considers venous cavities, and either terminate abruptly, or swell out into a club-like process without again subdividing. These vessels when they project into the venous cavities, according to Müller, are not entirely naked, but are covered by a delicate membrane, which, under the microscope, appears granular, and when the arteries form a bundle, the whole bundle is covered by a

* A millimetre equals the 0.03937 of an English inch.

gause-like membrane. Müller considers this membrane as performing an important part in producing the phenomena of erection. These arteries have neither on their sides or extremities, any openings discoverable with the microscope; and when the blood, as is probable, escapes from them in large quantities into the venous cells during erection, it must either escape through invisible openings or by orifices which become enlarged by the dilatation of the arteries. These helicine arteries appear to have been seen by Weber, and figured in his plates, though not under that particular name, (Vide Tab. xxvi. Figs. xxvii. xxviii.)*
—The discovery of these vessels by Müller, though they do not by any means fully explain to us the phenomena of erectility, goes far towards reconciling the two conflicting opinions entertained upon this subject. That the cells formed by the septæ of the corpora cavernosum and spongiosum penis, are lined with the lining membrane and continuous with the cavity of the veins, there can, I think, be little doubt. For with the injecting pipe plunged at random in the cells of these parts, we invariably succeed in filling the superficial veins of the penis; and by inserting a pipe in the vena magna ipsius penis, we are equally successful in distending with injecting matter, the spongy cells. In these cells ramify the helicine arteries of Müller, by which the blood is conveyed with which the cells are distended by an injection throughout the arteries during erection.
—How far any coarctation or compression of the superficial veins at the root of the veins may assist this accumulation of blood in the cells, or whether it takes place at all, is not known.

* Müller's Archives, or London Medical Gazette, No. 423.

CHAPTER VI.

OF THE FEMALE ORGANS OF GENERATION.*

The female organs of generation consist of the *Uterus* and *Ovaries*, with their appendages; and of the *Vagina*, with the structure which surrounds its external orifice. The uterus is situated in the pelvis, between the bladder and rectum; and the ovaries are on each side of it. The vagina is a very large membranous canal, which passes from the uterus downwards and forwards, also between the bladder and rectum, and opens externally.

Connected with the orifice of the vagina are several bodies, which are called the *external parts of generation*, in order to distinguish them from the uterus and ovaries, and their appendages, and also from the canal of the vagina; which are called the *internal parts.*

The bladder of urine lies above and in contact with the vagina: the urethra is also intimately connected with it. The description of the bladder and urethra is therefore placed at the end of this chapter.

Of the External Parts of Generation.

—All the external parts of generation are included under the general term of *vulva.* They consist of the mons veneris, the labia externa, the fourchette, the fossa navicularis, the clitoris, the nymphæ, and the hymen.—

The adipose membrane, immediately anterior to the symphysis pubis, and on each side of it, forms a considerable prominence in females, which, at the age of puberty, is covered with hair, as in males. This prominence is denominated the *Mons Veneris.*

* For a very able and interesting account of the history and function of these organs, and of embryology, see Dunglison's Physiology, vol. 2, 4th edit.—P.

The exterior orifice commences immediately below this. On each side of this orifice is a prominence continued from the mons veneris, which is largest above, and gradually diminishes as it descends. These prominences have some hair upon them. They are called the *Labia Externa.* Their junction below is denominated the *Fourchette.* —The fourchette or *frenulum vulva*, is a delicate duplicature of the lining membrane, which forms the posterior commissure of the labia externa. In the virgin state it contracts the opening into the vagina, and behind it that canal forms a little depression or pouch. It is usually ruptured or effaced during the first act of parturition.— The space between the place of their junction and the anus is rather more than an inch in extent, and is denominated the *Perineum.*

—The perineal space between the vagina and rectum, extends upwards for about three inches, and terminates in a point; it is filled chiefly with cellular and adipose matter, through which many nerves and blood-vessels run, and is called the perineal triangle. This shares in the distention of the vagina during parturition, so that in the passage of the head of the child, there appears only interposed between it and the cavity of the rectum, a thin membranous layer.—

As the skin which forms the labia is continued internally, it becomes more thin and soft, and is covered by a more delicate cuticle. It is also more or less florid, and secretes a peculiar mucus.

In the upper angle, formed by the labia externa, is the upper extremity and glans of the clitoris.

The *Clitoris* is a body which has a very strong resemblance to the penis, but there is no urethra attached to it. It has two crura of considerable length, which originate, like those of the penis, from the crura of the pubis and ischium, and unite at the symphysis of the pubis so as to form a body, which is not much more than an inch in length, and is broad in proportion. The extremity of this organ, called the *Glans of the Clitoris*, forms a small tubercle, which is covered above and on the sides by a small plait or fold of the skin denominated *Prepuce.* These parts

are lubricated by a secretion similar to that which is observed round the glans penis.

The crura of the clitoris have muscles similar to the erectores penis. The interior structure of the *Clitoris* is very similar to that of the corpora cavernosa of the penis, or the corpus spongiosum of the urethra. It appears constructed for a similar distention, and is endued with the same sensibility as the penis. The two lateral parts are also separated from each other by a septum, resembling that of the penis. It is united to the symphysis pubis by a ligament.

The *Prepuce* of the clitoris has a semicircular form: below its extremities two folds or plaits commence, one on each side, which are situated obliquely with respect to each other, so as to form an angle. These folds are denominated the *Nymphæ.*

The *Nymphæ* or *Labia Interna* extend from the clitoris downwards nearly as far as the middle of the orifice of the vagina. They are situated within the external labia, and are formed by the skin after it has become more delicate in its texture. Their surface, however, is often somewhat corrugated. There are many blood-vessels in their internal structure, and it is supposed they are occasionally somewhat tumid. They are flat, and their exterior edge is convex; so that they are narrow at their extremities, and broad in the middle. Their breadth is very variable, and in some instances is great. In a majority of cases, it is equal to one-fourth of their length. Their colour in young subjects is of a bright red; in women advanced in years, and who have had many children, they are of a brown red, and sometimes of a dark colour.

The use of these parts is not very evident. They have been supposed to regulate the course of the urine as it flows from the urethra, but their effect in this respect is not great. They have also been supposed to favour the necessary enlargement of the parts in parturition.

—The nymphæ are larger usually in blacks than whites. They descend some distance below the labia externa, and constitute the *tabliérs* or aprons of the Hottentot females. The nymphæ are very vascular.

—The triangular and slightly concave depression, between the labia interna, about an inch or an inch and a quarter in length, is called the *Vestibulum*. The space between the posterior part of the orifice of the vagina, and the fourchette is called the *Fossa Navicularis*. On the surface of both these parts are observed reat number of mucous follicles.—

The orifice of the urethra is situated about an inch and one quarter farther inward than the clitoris. It is often rather less than the diameter of the urethra, and is somewhat protuberant. The orifices of mucous ducts are to be perceived around it.

The orifice of the urethra is at the commencement of the canal of the vagina. Immediately within this orifice is situated the membrane denominated *Hymen*.

The *Hymen* is an incomplete septum, made by a fold or duplicature of the membrane which forms the surface contiguous to it. Sometimes it is circular, with an aperture in the centre. Sometimes it has a resemblance to the crescent, the aperture being at the upper part of it. The hymen has frequently been found without a perforation, and has therefore prevented the discharge of the menstrual evacuation. It is generally ruptured in the first intercourse of the sexes; and some small tubercles, which are found on the surface of the vagina near the spot where it was situated, are supposed to be the remains of it. These tubercles are called *Carunculæ Myrtiformes*.

—Dr. Duvernoy, has found the hymen to exist in many of the inferior animals, in which it varies in regard to form, precisely as it does in the human race.—

Of the Vagina.

The canal of the vagina, commencing at the hymen and the orifice of the urethra, is rather more narrow at its beginning than it is farther inward. From this place it extends backwards and upwards, and partakes in a small degree of the curve of the rectum: while the bladder, which is above it, and rests upon it, increases the curvature of the anterior part. It is much larger in women who have had children than in those who have not.

—In the virgin state at puberty, its length is about five inches,

and its breadth, when moderately distended, one inch. In a natural state of the parts, there is no cavity, the surfaces of the mucous membrane being in contact. In women who have borne many children, its length diminishes, and its breadth increases in inverse proportion with each other.—

The membrane which lines the vagina resembles to a certain degree, the membranes which secrete mucus in different parts of the body. Its surface appears to consist of very small papillæ; and at the anterior extremity of the vagina it forms a great number of rugæ, which are arranged in a transverse direction, both on the part of the vagina connected to the bladder, and on that part which is connected to the rectum, while the lateral parts of the vagina are smooth. These rugæ are most prominent in the middle; so that a raised line appears to pass through them at right angles. This line extends from without inwards. The rugæ on the part next to the bladder are the strongest.

This arrangement of the surface of the vagina does not extend beyond the external half of the canal: on the internal half part, or that nearest the uterus, the surface is smooth.

The rugæ are considerably diminished in women who have had children.

Throughout this surface are to be seen, in some cases with the naked eye, the orifices of mucous follicles or ducts, which occasionally discharge considerable quantities of mucus.

—Near the external orifice of the vagina, exist a couple of little glands, somewhat resembling those of Cowper, which discharge through their ducts a lubrifying mucus on the surface of the membrane.—

Exterior to the lining membrane of the vagina is a dense cellular structure, which has not yet been completely investigated: it is of a lightish colour, and has some resemblance to the texture of the body of the uterus. It is very vascular, and appears to be of a fibrous structure. It may be very much distended, and seems to have a contractile power.

At the anterior extremity of the vagina, on each side of it, there is superadded to this, a cellular, or vascular substance, from eight lines to an inch in breadth: which, when cut into,

resembles the corpora cavernosa, or the corpus spongiosum of the penis. These bodies commence near the body of the clitoris, and extend downwards on each side of the vagina. They have been called *Plexus Retiformis*, and *Corpora Cavernosa Vaginæ*, and are occasionally distended with blood, like the clitoris and penis.

These corpora cavernosa are covered by muscular fibres, which pass over them on each side from the sphincter ani to the body of the clitoris; to each of which organs they are attached. These fibres constitute the sphincter vagina muscle, and contract the diameter of the vagina at the place where they are situated.*

The transversus perinei muscles also exist in the female. They pass from the tuberosities of the ischia, and are inserted into a dense whitish substance in the perineum, to which the anterior extremity of the sphincter ani is likewise attached.

The vagina is in contact with the rectum behind; the bladder lies upon it and anterior to it. A small portion of peritoneum, to be reflected to the rectum, is continued from the uterus upon the posterior part of it. The lateral portions of it are invested with cellular substance. The anterior extremity of the uterus, which is called the Os Tincæ, projects into it from above.

Of the Uterus, the Ovaries and their Appendages.

The *Uterus* has been compared to a pear with a long neck. There is, of course, a considerable difference between the body and neck; the first being twice as broad as the last. Each of these parts is somewhat flattened.

In subjects of mature age, who have never been pregnant, the whole of the uterus is about two inches and a half in length, and more than one inch and a half in breadth at the broadest part of the body: it is also near an inch in thickness.

It is generally larger than this in women who have *lately* had children.

* These two muscular bands, which when conjoined together form the sphincter vaginæ, have a similar origin and insertion and correspond with the acceleratores urinæ muscles of the male.—P.

The uterus is situated in the pelvis between the bladder and rectum, and is enclosed in a duplicature or fold of the peritoneum, which forms a loose septum that extends from one side of the pelvis to the other, and divides it into an anterior and posterior chamber. The posterior surface of this septum is opposed to the rectum, and the anterior to the bladder. The two portions of this septum which are between the uterus and the lateral parts of the pelvis, are called the *Broad Ligaments.*

On the posterior surface, the *Ovaries* are situated on each side of the uterus, being enclosed by a process of the ligament or septum. Above them, in the upper edge of the septum, are the *Fallopian Tubes,* which are ducts that commence at the upper part of the uterus on each side, and proceed in a lateral direction for some distance, when they form an angle and incline downwards to the ovaries. These ducts are enclosed between the two lamina of the septum for the greater part of their length.

The peritoneum which forms the septum, is reflected from it, posteriorly, to the rectum, and the posterior surface of the pelvis, and anteriorly to the bladder. In its progress in each direction, it forms small plaits or folds; two of which extend from the uterus to the rectum posteriorly, and two more to the bladder anteriorly: these are called the *Anterior and Posterior Ligaments of the Uterus.*

The other ligaments, which proceed more immediately from the uterus, are called the *Round Ligaments.* These arise from each side of the uterus, at a small distance before and below the origins of the Fallopian tubes, and proceed in an oblique course to the abdominal rings. These ligaments are also invested by the peritoneum. They pass through the rings and soon terminate.

In the body of the uterus is a cavity, which approaches to the triangular form, and from which a canal proceeds through its neck. This cavity is so small that its sides are almost in contact, and the canal is in proportion; so that this organ is very thick in proportion to its bulk.

The substance of which the uterus consists is very firm and dense: it is of a whitish colour, with a slight tinge of red. There are many blood-vessels, with nerves and absorbent vessels, in its

texture. The nature and structure of this substance has not yet been precisely ascertained. It appears very different indeed from muscle; but the uterus occasionally contracts, with great force, during labour. It is not rendered thin by its enlargement during pregnancy, and the blood-vessels in its texture are generally enlarged at that time.

—The proper tissue of the uterus in its *ordinary condition*, is of a grayish colour, and of a density almost cartilaginous, especially in its neck. It is composed of fibres, the nature and arrangement of which it is then impossible to determine. When enlarged by *gestation*, its tissue is soft, reddish, very dilatable, contractile, and presents all the characters of muscular tissue. Its fibres* are arranged in the following manner:—

—*In the body* of the uterus they form two layers, one *superficial* and one *deep-seated.* The former is composed first, of a vertical fasciculus, which runs over the anterior and posterior faces of the organ; of a second fasciculus, which runs along the superior border of the fundus, and of several other oblique layers, which may be traced upon the Fallopian tubes, round ligaments, broad ligaments, and ligaments of the ovaries. In many animals, as in the cow, we find the broad ligament a mass of muscular fibres continuous with the uterus.

—The *second* or *deep-seated*, form two cones, which are connected by their bases upon the median line, and by their apices to the Fallopian tubes. The *neck* of the uterus is composed entirely of circular fibres, closely compacted together.—

Exteriorly, the uterus is covered by the peritoneum, as has already been mentioned. Internally it is lined with a delicate membrane that has some resemblance to those which secrete mucus, and is generally of a whitish colour, abounding with small orifices that can be seen with a magnifying glass. This membrane is so intimately connected to the substance of the uterus, that some anatomists have supposed it was merely the internal surface of that substance, but this opinion is now gene-

* The best description of the fibres of the uterus is that of Madame Boivin. Vide Maladies de l'Uterus, etc. by Mad. Boivin and A. Duges. Paris.—P.

rally abandoned. It is supposed that the colour of this membrane is more florid about the period of menstruation.

The cavity of the uterus, as has been observed before, is triangular in form. When the organ is in its natural position, the upper side of this triangle is transverse with respect to the body, and the other sides pass downwards and inwards. In each of the upper angles are the orifices of the Fallopian tubes, which are of such size as to admit a hog's bristle.

The two lower lines of the triangle are slightly curved outwards at their upper extremities; so that the upper angles of the triangle project outwards and the orifices of the Fallopian tubes are nearer to the external surface than they otherwise would be.

The lower angle of the cavity of the uterus is occupied by the orifice of the canal, which passes through the neck of the organ; this orifice is from three to four lines in diameter. The canal is about an inch in length, and is rather wider in the middle than at either end. On the anterior and posterior portions of its surface are many small ridges which have an arborescent arrangement, one large ridge passing internally from the commencement of the canal, from which a number of other ridges go off in a transverse direction. These ridges extend nearly the whole length of the canal. In the grooves, between the ridges, are the orifices of many mucous ducts.

—These folds or ridges all disappear during gestation, and their singular arrangement serves to explain, how the neck is capable, when expanded, of forming a third part of the general uterine cavity, at the latter period of gestation.—

There are also on the surface a number of transparent bodies of a round form, equal in bulk to a middle-sized grain of sand, the nature and use of which is unknown. They have been called *Ovula Nabothi*, after a physiologist who published some speculations respecting their use, about the commencement of the last century.

—These are now generally believed to be the mucous follicles of the neck of the uterus in a state of vesicular distention, the orifices of which have been obliterated.—

The canal of the neck of the uterus is very different from

other ducts, for it seems to be a part of the cavity to which it leads, and when the cavity of the uterus becomes enlarged in the progress of pregnancy, this canal is gradually converted into a part of that cavity.

The lower extremity of the neck of the uterus is irregularly convex and tumid. The orifice of the canal in it, is oval, and so situated that it divides the convex surface of the neck into two portions, which are called the *Lips.* The anterior or upper portion is thicker than the other.

This extremity of the uterus protrudes into the vagina, and is commonly called *Os Tincæ.* As the anterior portion or lip is larger and more tumid than the posterior, the vagina extends farther beyond the os tincæ on the posterior part than on the anterior.

The Fallopian Tubes

Are two canals, from four to five inches in length, which proceed between the lamina of the broad ligaments, from the upper angles of the uterus, in a transverse direction, to some distance from the uterus, when they form an angle, and take a direction downwards towards the ovaries.

They are formed, for a considerable part of their extent, by a substance which resembles that of which the uterus consists, and are lined by a membrane continued from the internal membrane of the uterus. Their extremities appear to be composed of membrane, which is rendered florid by the blood-vessels in its texture. At the commencement, their diameters are extremely small; but they enlarge in their progress. This enlargement is gradual for the first half, and afterwards sudden; the enlarged part is more membranous than the small part, and has a bright red colour. The large extremity is loose in the cavity of the pelvis, and is not invested by the lamina of the broad ligaments. Near the termination the diameter is often contracted; after which the membrane which forms the tube expands into an open mouth, the margin of which consists of fringed processes: this margin is also oblique, as respects the axis of the tube; and the different fringed processes are not all of the same length; but the

longest are in the middle, and the others regularly diminish on each side of them: these processes constitute the *Fimbriæ* of the Fallopian tubes.

The internal surface of the large extremities of these tubes is extremely vascular; and there are some longitudinal fibres of a red colour to be seen on it.

—More recent investigations into the structure of the Fallopian tubes, have shown that they are composed in some respect like the urethra: of a canal lined by a mucous membrane, and of an erectile spongy body without, like the corpus spongiosum. —When this spongy substance is distended by a fine size injection, I have found it bowed upwards as if in a state of erection, and the *Fimbriæ* or *Morsus Diaboli*, which are likewise rendered turgid, spread themselves out upon the ovary, so that the dilated funnel-shaped cavity of the tube is in contact with this organ. One or two of the longest of these fimbriæ are usually attached to the external margin of the ovary. Sometimes they are all found adherent as a consequence of accidental inflammation. In a young girl dead six or seven weeks after conception, Madame Boivin, found the trumpet-shaped extremity of the left tube curved over the ovary so as to cover it almost entirely, and all the fimbriæ strongly adherent to its surface. At the orifice of the tube was a membranous cyst, of the size of a hazle-nut, filled with a yellowish serum, and covered with minute red vessels. This interesting fact is in support of the function attributed to these organs during fecundation: that of grasping the ovary with its fimbriæ, and sucking in the ovum when detached, which in ordinary cases it transmits to the womb.
—There is reason to believe, that the pathological changes of the distal extremity of this tube, are frequent cause of sterility. It is so frequently found diseased in the class of subjects with which our anatomical rooms are supplied, that it is even difficult to procure a perfectly healthy specimen of the parts. The morbid changes that I have most frequently met with, are an agglutination of the end of the tube to the ovary or broad ligaments, its occlusion by inflammation or the developement in it of hydated vesicles.—

The Round Ligaments

Which have already been mentioned, are cords of a fibrous structure, with many blood-vessels in them. They arise from the uterus below the origin of the Fallopian tubes, and proceed under the anterior lamina of the broad ligaments to the abdominal rings through which they pass; and then the fibres and vessels are expanded upon the contiguous cellular substance of the mons veneris and labia externa.

The Ovaries, (Testes Muliebres,)

Are two bodies of a flattened oval form; one of which is situated on each side of the uterus on the posterior surface of the broad ligament, and invested completely by a process of the posterior lamen, which forms a coat, and also a ligament for it. The size of this organ varies in different subjects, but in a majority of those who are about the age of maturity, it is between ten and twelve lines in length. It is connected to the uterus by a small ligament (called *ovarian*) or bundle of fibres of the same structure with the round ligaments, which is not more than two lines in diameter, and is included between the lamina of the broad ligament.

The process of the broad ligament forms an external serous coat to the ovary; within this is the proper coat of the organ, (tunica albuginea,) which is a firm membrane. This membrane is so firmly connected to the substance of the ovary which it encloses, that it cannot be easily separated from it. The ovary is of a whitish colour and soft texture, and has many blood-vessels. In virgins of mature age it contains from ten to twenty vesicles, formed of a delicate membrane, filled with a transparent coagulable fluid. Some of these vesicles are situated so near to the surface of the ovary, that they are prominent on its surface; others are near the centre. They are very different in size; the largest being between two and three lines in diameter, and others not more than one-third of that size.

In women who have had children, or in whom conception has

taken place, some of these vesicles are removed, and in their place a cicatrix is found.

It has been ascertained, that during the sexual intercourse with males, one of these vesicles, which was protuberant on the surface, is often ruptured, and a cavity is found. A cicatrix is soon formed, where the membrane was ruptured; and in the place occupied by the vesicle there is a yellow substance denominated *Corpus Luteum*. This corpus luteum generally continues until the middle of pregnancy: it often remains during that state, and for some time after delivery, but it gradually vanishes. The cicatrization continues during life.

In many cases these cicatrices correspond with the number of conceptions which have taken place; but they often exceed the number of conceptions, and they have been found in cases where conception has not been known to have taken place.

In very old subjects, where conception has never taken place, the vesicles are either entirely removed, or small dense tubercles only remain in their place.

—These vesicles have been called the *ova* or *vesiculæ Graafianæ*, in honour of Regnier De Graaf, who described them with care, though their existence had been previously pointed out by Vesalius and Fallopius.

—These vesicles, as they increase in size at the approach of puberty, or from the effect of sexual excitation, make their way gradually to the surface of the ovary. In two instances where death had occurred under peculiar circumstances, I have seen vesicles of the largest size seated as it were, in a little cup-like depression of the ovary, with the peritoneal lining raised in relief above them. A slight blush of inflammation could be seen on the walls of the vesicles, through the peritoneum, which corresponds with the description given by De Graaf, of the first stages of conception in the cow. One of these ovaries I steeped in boiling water, and found the vesicles it contained, the largest of which was about three lines in diameter, to consist of two membranes, separable from each other, the inner one containing a limpid albuminous fluid, which had been coagulated by the heat. Within these vesicles, after fecundation, according to De Graaf,

Prévost, Dumas, etc., are developed smaller ones, which are the proper *ovula Graafiana.* These constitute the proper germ or ovum, which finally escapes by the laceration of the walls of the outer vesicle, and is taken up by the prehensile action of the Fallopian tube. The lacerated walls of the outer vesicle, give issue to some blood, secrete a yellowish fluid, and thus constitute the corpus luteum.—

The Arteries

Of the uterus are derived from two very different sources; namely, from the spermatic and from the hypogastric arteries.

The spermatic arteries, instead of passing directly down to the abdominal ring, proceed between the lamina of the broad ligament, and send branches to the ovaries, which may sometimes be traced to the vesicles. They also send branches to the Fallopian tubes and to the uterus. Those which are on the opposite sides of the uterus anastomose with each other, and also with the branches of the hypogastric arteries. There are also branches of these arteries in the round ligaments which accompany them to their termination outside of the abdominal ring.

The principal arteries of the uterus are those derived from the hypogastric, which sends to each side of it a considerable branch, called the *Uterine.* This vessel leaves the hypogastric very near the origin of the internal pudic, and proceeds to the cervix of the uterus: it passes between the lamina of the broad ligaments, and sends branches to the edge of the uterus, which penetrate its texture. The branches which are in the texture of the uterus are very small, indeed, in young subjects. In women who have had children, they are considerably larger; but during pregnancy they gradually enlarge with the growth of the uterus, and become very considerable. These arteries observe a *serpentine and peculiarly tortuous* course. Those on the opposite sides anastomose with each other.

The Veins

Of the uterus, like the arteries, form spermatic and uterine trunks. The spermatic vein is much larger than the artery.

It ramifies, as in males, and forms, a very large plexus, which constitutes the corpus pampiniforme. Many of the veins which form this body, originate near the ovary: a considerable number also come from the Fallopian tubes and the uterus. The spermatic vein and its branches are greatly enlarged indeed during pregnancy; and it is said that they are enlarged the same way during the menstrual discharge.

The most important veins of the uterus are the branches of the *Uterine Veins.* They are extremely numerous, and form a plexus on the side of the uterus; from which two or more uterine veins proceed in the course of the artery, and join the hypogastric. These veins also are greatly enlarged during pregnancy. Some of these are so large as to receive the end of the little finger, and are called uterine sinuses, though improperly.

The Lymphatic Vessels

Of the uterus, and its appendages, are very numerous. In the unimpregnated state they are small; but during pregnancy they increase greatly. They proceed from the uterus in very different directions. Some that accompany the round ligaments go to the lymphatic gland of the groin. Others, which take the course of the uterine blood-vessels, pass to glands in the pelvis, and a third set follows the spermatic arteries and veins to the glands of the loins.

The Nerves

Of the ovaries are derived from the renal plexus, and those of the uterus and vagina from the hypogastric plexus, or the lower portions of the sympathetic, and the third and fourth sacral nerves.

Of the Bladder and Urethra.

The situation of the *Bladder*, as respects the symphysis pubis, is nearly alike in both sexes; but that part of it which is immediately behind the insertion of the uterus is rather lower in males than in females. The bottom of the bladder rests upon the

upper part of the vagina, a thin stratum of cellular substance intervening: when that viscus is distended it forms a tumour which compresses the vagina.

The ureters are inserted, and the urethra commences in the same part of the bladder, in both sexes.

The length of the *Urethra* is between one and two inches. When the body is in an erect position, it is nearly horizontal; but it is slightly curved, with its convexity downwards. It is immediately above the vagina, and it passes below the body of the clitoris. The external orifice is rather more than an inch within the glans or head of the clitoris. This orifice is somewhat prominent in the vagina.

—In young persons, the external orifice of the urethra is immediately below the symphysis of the pubis, and nearly level with the anterior face of that bone.

—In women who have borne many children, the urethra is retracted or shortened, so as to be rarely more than an inch in length, and the orifice will be found behind the pubis, near its posterior face. A knowledge of these facts will render the introduction of the catheter in many cases more easy.—

In the internal lining membrane of the urethra there are many orifices of mucous follicles, and also longitudinal wrinkles, as in the urethra of males. The diameter of the female urethra and its orifice in the bladder are larger than they are in the male. For this reason it has been supposed, that women are less liable to calculus of the bladder than men.*

The urethra is intimately connected with the external coat of the vagina, and between them there is a spongy cellular substance which makes the rough surface of the vagina prominent; so that the urethra has been supposed, although erroneously, to be invested with the prostate. It is capable of great artificial dilatation. Its diameter in the natural state is about a quarter of an inch.

* It has, however, been asserted that they are also less liable to calculi in the kidneys.

Of the Changes induced in the Uterus in the progress of Pregnancy.

The alteration which takes place in the size of the uterus during pregnancy is truly great. About the conclusion of that period, instead of the small body above described, which is almost solid, the uterus forms an immense sac, which extends from the termination of the vagina in the pelvis, into the epigastric region, and from one side of the abdomen to the other; preserving, however, an ovoid figure.

This change is so gradual at first, that the uterus does not extend beyond the cavity of the pelvis before the third month, although at the end of the seventh month it is very near the epigastric region.

For the first six months the body of the uterus appears principally concerned in the enlargement: after this the cervix begins to change, and is gradually altered so as to compose a portion of the sac, of rather less thickness than the rest of the uterus; the mouth being ultimately an aperture in a part which is much thinner than the other portions of the organ.

The change which takes place in the texture of some of the appendages of the uterus is very important.

The *Broad Ligaments*, which seem particularly calculated to favour the extension of the uterus, are necessarily altered by the change in the size of that organ, but not entirely done away. The portion of peritoneum of which they are formed must be very much enlarged with the growth of the uterus, as it continues to cover it. The *Round Ligaments* are much elongated; and they observe a more straight course to the abdominal ring. The *Fallopian Tubes* are enlarged; and instead of passing off laterally from the uterus, they now proceed downwards by the side of it. The *Ovaries* appear rather larger and more spongy: their relative situation is necessarily lower.

The *change in the Uterus itself* is particularly interesting. The great increase of its size is not attended with any considerable diminution of thickness in its substance; *nor are the arteries much less convoluted than before pregnancy*, as might have been

expected. They are greatly enlarged in diameter, and the orifices of the exhalent vessels on the internal surface of the uterus are much more perceptible.

The veins are much more enlarged than the arteries, and in some places appear more than half an inch in diameter. They are not regularly cylindrical, but rather flat. They anastomose so as to form an irregular net-work.

The uterus appears much more fibrous and muscular in the gravid than in the unimpregnated state. The contractile power of the gravid uterus is not only proved by the expulsion of its contents, but also by very vigorous contractions, which are occasionally observed by accoucheurs.

Although the general effects which result from the particular conditions of the uterus in pregnancy, menstruation, &c., evince that the influence of this organ upon the whole system is very great, yet it seems probable that the sexual peculiarities of females are especially dependent upon the ovaria.

This sentiment is confirmed by an account of a woman in whom the ovaria were deficient, which is published in the London Philosophical Transactions for 1805, by Mr. C. Pears. The subject lived to the age of twenty-nine years. She ceased to grow after the age of ten years, and therefore was not more than four feet six inches in height: her breadth across the hips was but nine inches, although the breadth of the shoulders was fourteen. Her breast and nipples were never enlarged more than they are in the male subject. There was no hair on the pubes, nor were there any indications of puberty in mind or body. She never menstruated. At the age of twenty-nine she died of a complaint in the breast, attended with convulsions. The uterus and os tincæ were found not increased beyond their usual size during infancy. The cavity of the uterus was of the common shape, but its coats were membranous. The Fallopian tubes were pervious. "*The Ovaria were so indistinct that they rather showed the rudiments which ought to have formed them, than any part of the natural structure.*"

Another case, which confirms the aforesaid sentiment, is related in one of the French periodical publications.

It has been long known that a race of savages near the Cape of Good Hope were distinguished from the generality of their species by a peculiarity about the pudendum. An account of this structure has been given with some precision by Messrs. Peron and Lesueur, in a paper which was read to the National Institute of France. It is a flap or apron, four inches in

length, which is united to the external labia near their upper angle, and hangs down before the clitoris and the external orifice of the parts of generation. It is divided below into two lobes, which cover the orifice. It is formed by a soft distensible skin, free from hair, which is occasionally corrugated like the scrotum, and is rather more florid than the ordinary cutis.* —This is the *tablier*, or mere natural enlargement of the nymphæ, common to the females of some races of men.—

The Abdomen of the Fœtus.

The difference between the fœtus and the adult, in the cavity of the abdomen, is very conspicuous at the first view.

The *Liver* in the fœtus is so large that it occupies a very considerable part of the abdomen. Its left lobe, which is larger in proportion than the right, extends far into the left hypochondriac region.

The *Bladder of urine*, when filled, extends from the cavity of the pelvis a considerable distance towards the umbilicus: so that the greatest part of it is in the cavity of the abdomen. A ligament of a conical figure extends from the centre of the upper part of the bladder to the umbilicus, with an artery on each side of it, which is soon to be described. This ligament, which is in the situation of the urachus of the fœtus of quadrupeds, is hollow, and thus frequently forms a canal, which has a very small diameter, that communicates with the bladder by an aperture still smaller, and continues a short distance from the bladder towards the umbilicus. In a few rare instances, this canal has extended to the umbilicus, so that urine has been discharged through it, but the ligament is commonly solid there.

The *Stomach* appears to be more curved in the fœtus than in the adult.

The *Great Intestine* does not extend sufficiently far, beyond the insertion of the ileon, to form the cæcum completely.

The *Glandulæ Renales* are much larger in proportion in the

* This paper has not yet been published by the Institute, but it is referred to by M. Cuvier in his Leçons d'Anatomie Comparée, vol. v. page 124.—Messrs. Peron and Lesueur were naturalists who accompanied captain Baudin in his voyage of discovery; the latter has been for some years resident in Philadelphia.

fœtus than in the adult. The colour of the fluid they contain is more florid.

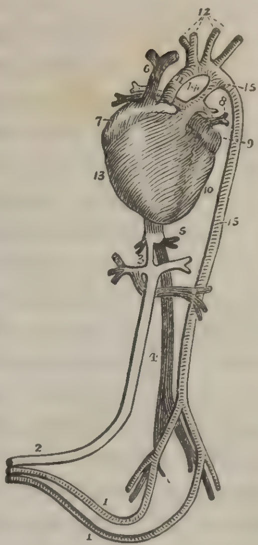
The *Kidneys* are lobulated.

The *Testicles* in the fœtus are found above the pelvis, in the lumbar region, behind the peritoneum, until two months before birth. Thus situated, their blood-vessels and nerves proceed from sources which are near them; but the vas deferens, being connected to the vesiculæ seminales by one extremity, is necessarily in a very different situation from what it is in the adult: it proceeds from the testicle downwards to the neck of the bladder. While each testicle is in this situation, it is connected with a substance or ligament, called *Gubernaculum*, of a conical or pyramidical form, which is attached to its lower end, and extends from it to the abdominal ring. This substance is vascular, and of a fibrous texture: its large extremity adheres to the testicle, its lower and small extremity passes through the abdominal ring, and appears to terminate in the cellular substance exterior to that opening, like the round ligament in females. The *Gubernaculum*, as well as the testicle, is behind the peritoneum; and the peritoneum adheres to each of them more firmly than it does to any of the surrounding parts. It seems that, by the contraction of the *Gubernaculum*, the testicle is moved down from its original situation to the abdominal ring, and through the abdominal ring into the scrotum. The peritoneum, which adheres firmly to the gubernaculum and testicle, and is loosely connected to the other parts, yields to this operation; and when the testicle has arrived near the abdominal ring, a portion of the peritoneum is protruded a little way before it into the scrotum; forming a cavity like the finger of a glove. The testicle passes down behind this process of the peritoneum, and is covered by it as it was in the abdomen. Although it appears protruded into the cavity, it is exterior to it, and behind it; and the vessels, &c. which belong to the testicle are also exterior to it.

The cavity formed in the scrotum, by this process of the peritoneum, necessarily communicates with the cavity of the abdomen at its formation; but very soon after the testicle has descended into the scrotum, the upper part of this cavity is closed

up, while the lower part of the process continues unchanged, and constitutes the *Tunica Vaginalis Testis.* In some instances the upper part of this process does not close up, and the communication with the cavity of the abdomen continues. The descent of the intestine into the cavity thus circumstanced, constitutes that species of hernia which is denominated *Congenital.*†

Fig. 65.*



The *most important* peculiarities in the abdomen of the fœtus are those connected with the circulation of the blood.

The internal iliac or hypogastric arteries are larger than the external iliacs. Their main trunks are continued on each side of the bladder to its fundus, and proceed from it, with the ligament, to the umbilicus; when they pass out of the abdomen to go along the umbilical cord to the placenta. These arteries are now denominated the *Umbilical,* and are very considerable in

* Diagram of the circulation in the human fœtus. 1, 1, Umbilical arteries. 2, Umbilical vein. The blood of the umbilical vein is partly distributed to the liver, in the right tube of which it becomes mixed with the blood of the porta, and in part passes directly by the ductus venosus 3, to the vena cava inferior, 4. 5, Venæ cavæ hepaticæ. 6, Superior cava. 7, Right auricle. 8, Pulmonary veins. 9, Left auricle. 10, Left ventricle. 11, Ascending aorta or left arch of the aorta. 12, Vessels to the head and upper extremities. 13, Right ventricle. 14, Ductus arteriosus, or right aortic arch. 15, Descending aorta.—P.

† These interesting circumstances respecting the original situation of the testicle, and its descent into the scrotum, were discovered and elucidated by Haller, Hunter, Pott, Camper, and several other very respectable anatomists and surgeons. There is, however, a difference of opinion between some of them, as to the time when the testicle leaves the abdomen. Haller thought the testicles were seldom in the scrotum at birth. Hunter and Camper found them so generally.

It has been suggested that there are some national peculiarities in this respect; that amongst the Hungarians, for example, the testicles often remain above the abdominal ring until near the age of puberty.

The student will find an interesting description of the situation of the testis, and its descent in the fœtus, in the "Observations on certain parts of the Animal Economy," by John Hunter.

size. After birth, as there is no circulation in them, they soon begin to change: their cavity becomes gradually obliterated, and they are converted into ligaments. They are exterior to the peritoneum, and contained in a duplicature of it.

A vein also called the *Umbilical*, which is much larger in diameter than both of the arteries, returns from the placenta along the cord, and enters the cavity of the abdomen at the umbilicus. It proceeds thence, exterior to the peritoneum, but in a duplicature of it called the *Falciform Ligament*, to the liver, and enters that viscus at the *great fissure;* along which it passes to the left branch of the sinus of the vena portarum, into which it opens and discharges the blood which flows through it from the placenta. It opens on the anterior side of the branch of the vena portarum, and from the posterior side of the branch, opposite to this opening, proceeds a duct or canal, which opens into the left hepatic vein near its junction with the vena cava. This communicating vessel is called the *Ductus*, or *Canalis Venosus;* to distinguish it from the duct which passes from the pulmonary artery to the aorta, and is called *Ductus*, or *Canalis Arteriosus*. This venous duct carries some of the blood of the umbilical vein directly to the vena cava; but it is much smaller than the umbilical vein, and of course a considerable quantity of the blood which passes through the umbilical vein must pass through the liver, by the vena portarum, before it can enter the cava.

In some fœtal subjects, if a probe of sufficient length be introduced within the umbilical vein and pushed forwards, it will pass to the heart, without much difficulty or opposition, as if it proceeded along one continued tube, although it really passes from the umbilical vein across the branch of the vena portarum, and then through the ductus venosus, and through a portion of the left hepatic vein, into the inferior vena cava.

If the umbilical vein be injected with a composition, which will be firm when cool, it appears to terminate in a rounded end, which is situated in the transverse fissure of the liver: the sinus of the vena portarum, into which this vein enters, appears like two branches going off, one from each side of it, and the ductus venosus like a branch continuing in the direction of the main trunk of the umbilical vein.

The umbilical vein, in its progress through the fissure of the liver, before it arrives at the sinus of the vena portarum, sends off a considerable number of branches to each of the lobes of that organ, but more to the left than to the right lobe.

After birth, when blood ceases to flow through the umbilical vein, it is gradually converted into a ligament; and the venous duct is also converted into a ligament in the same manner. The vena portarum, which before appeared very small, when compared with the umbilical vein, now brings all the blood which fills its great sinus, and increases considerably in size.

It has been ascertained by anatomical investigation, that the umbilical arteries above mentioned, after ramifying minutely in the placenta, communicate with the minute branches of the umbilical vein; and it is probable that the whole blood carried to the placenta by these arteries, returns by the umbilical vein to the fœtus.

It is clearly proved by the effects of pressure on the umbilical cord, in cases of delivery by the feet, as well as by other similar circumstances, that this circulation cannot be suspended for any length of time without destroying the life of the fœtus. From these circumstances, and from the florid colour which the blood acquires by circulating in the placenta, it seems probable that the object of the circulation through that organ is somewhat analogous to the object of the pulmonary circulation through the lungs of adults.*

* During the first four months of pregnancy a very small vesicle, which does not exceed the size of a pea, is found between the chorion and the amnios, near the insertion of the umbilical cord into the placenta. It is connected to the fœtus by an artery and a vein, which pass from the abdomen through the umbilicus, and proceeding along the cord to the placenta, continue from it to the vesicle. The artery arises from the mesenteric, and the vein is united to the mesenteric branch of the vena portarum. It is probable that these vessels commonly exist no longer than the vesicle, namely, about four months; but they have been seen by Haller and Chaussier at the termination of pregnancy. They are called *Omphalo-Mesenteric* vessels. The vesicle is denominated the *Umbilical Vesicle.*

This inexplicable structure is delineated in Hunter's Anatomy of the Gravid Uterus, plate xxxiii. figures v. and vi.; in the Academical Annotations of Albinus, first book, plate i. figure xii.; and also in the Icones Embryonum Humanorum of Soemmering, figure ii.

PART VIII.

GENERAL ANATOMY OF THE SANGUIFEROUS SYSTEM.

CHAPTER VII.

OF THE BLOOD-VESSELS IN GENERAL. GENERAL ANATOMY OF THE ARTERIAL SYSTEM. GENERAL REMARKS UPON THE HEART. GENERAL ANATOMY OF THE VENOUS SYSTEM.

Of the Blood-vessels in General.

The blood-vessels are flexible tubes, of a peculiar texture, through which blood passes from the heart to the different parts of the body, and returns again from these parts to the heart. They are to be found, in varying proportions, in *almost every* part of the body, and seem to enter into its texture.

The tubes which carry blood *from* the heart, are more substantial and more elastic than those through which it returns to the heart. They are generally found empty after death; and, therefore, were called *Arteries* by the ancient anatomists, who supposed that they carried air, and not blood.

The tubes which return the blood to the heart are denominated *Veins.* They are less substantial and less elastic than arteries, and are generally full of blood in the dead subject.

There are two great arteries, from which all the other arterial vessels of the body are derived. They are very justly compared to the trunks of trees, and the smaller vessels to their branches. One of these great arteries, called the *Aorta*, carries blood to every part of the body. The other great vessel, called the *Pulmonary Artery*, carries blood exclusively to the lungs.

The veins which correspond to the branches of the *Aorta*, unite to each other, so as to form the two great trunks that proceed to the heart. One of these trunks, coming from the superior parts of the body, is called the *Superior*, or *Descending*

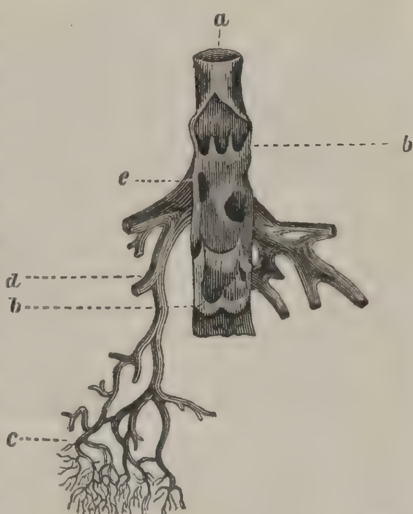
Vena Cava. The other, which comes from the lower parts of the body, is called the *Inferior*, or *Ascending Vena Cava.*

The veins which correspond with the branches of the *Pulmonary Artery*, and return to the heart the blood of the lungs, are four in number; two of them proceeding from each lung. They are called *Pulmonary Veins.*

In many of the veins there are valves which prevent the blood they contain from moving towards the surface and extremities of the body, but allow it to pass towards the heart without impediment.

From the construction of the cavities of the heart, and the position of the valves which are in them, as well as the situation of the valves at the commencement of the *great arteries*, and the above mentioned valves of the veins, it is evident, that when the blood circulates, it must move from the heart, through the aorta and its branches, to the different parts of the body, and return from these parts through the venæ cavæ, to the heart; that, when deposited in the heart by the venæ cavæ, it must proceed through the pulmonary artery to the lungs, and return from the lungs through the pulmonary veins to the heart, in order to pass again from that organ into the aorta.

Fig. 66.*



* Fig. 66. Trunk of a large vein, laid open in order to exhibit the valves, formed by doublings of the internal lining membrane. *a*, Superior portion of the vein, or that towards the heart. *b*, Valves, the concavity of which is directed towards the heart. *c*, Branches of the veins, anastomosing together, and uniting to form a large branch *d*, which opens into the principal trunk at *e*.—P.

It is also certain, that the blood is forced from the heart into the arteries, by the contraction of the muscular fibres of which the heart is composed; and that the blood-vessels likewise perform a part in the circulation, they propelling the blood which is thus thrown into them: but their action appears to depend upon causes of a complex nature.

General Anatomy of the Arterial System.

The arteries are so much concerned in the important function of the circulation of the blood, that every circumstance connected with them is very interesting.

They are composed of coats or tunics, which are very elastic and strong, and which are also very thick. In consequence of the firmness of their coats, they continue open, after their contents are discharged, like hard tubes. They submit to great dilatation, and elongation, when fluids are forced into them, and return to their former dimensions when the distending cause is withdrawn. This elasticity is particularly subservient to the circulation of the blood. It admits the artery to distend readily, and receive the blood which is thrown into it by the contraction of the heart. It also produces the contraction of the artery; which takes place as soon as the action of the heart ceases; and this contraction of the heart necessarily forces the blood forward, as the valves at its orifice prevent it from returning to the heart.

The motion of the artery, which is so easily perceived by the touch, and in many instances also by the eye, is completely explained by the discharge of blood into the artery from the heart, and by the elasticity of the vessel, by which it reacts upon the blood. In some cases it is not simply the diameter of the artery which is enlarged, but a portion of the vessel is elongated; and this elongation, by producing a curvature of it, renders its motion more visible.

In the aorta, and probably in its large branches *Elasticity* seems to be the principal cause of the continuance of the motion which is originally given to the blood by the heart. But there are many circumstances connected with the smaller vessels,

which evince that they exert a power which is very different indeed from elasticity. Thus, the application of local stimulants or rubefacients, and of heat, is followed by an increase of motion in the arteries of the parts to which they are applied. Neither of these causes could produce their effect by the influence of elasticity: but the effect of these and other similar causes is uniformly produced; and a power of independent motion, or *Irritability*, is thus proved to exist in these vessels, and seems essentially necessary to the circulation of the blood.

The Structure of the Arteries

Is, therefore, a subject of importance, and has received a considerable degree of attention from anatomists.

They are composed of a dense *elastic* substance, of a whitish colour. Their external surface is rough, and intimately connected with the cellular membrane, which every where surrounds it in varying quantities. Internally, they are lined with a thin membrane, which is very smooth and flexible, and is also very elastic. The substance which composes the artery, and is situated between the cellular investment and the internal membrane, consists of fibres, which are nearly, though not completely circular, but so arranged as to constitute a cylinder. These fibres may be separated from each other so as to form lamina, which have been considered as different coats of the arteries; but there is no arrangement of them which composes regular distinct strata. The coats of arteries may, therefore, be separated into a greater or smaller number of lamina, according to the thickness of these lamina.

The fibres which compose these lamina appear to be united to each other in a way which readily allows of their separation, at the same time that they form a firm texture. Although arteries thus appear essentially different from muscles in their hardness and their elasticity, as well as in their general texture, they are considered, by a great majority of anatomists, as partaking more or less of a muscular structure.

In the human subject their structure is very difficult of demonstration, and great differences exist in the accounts which are

given of it, even by anatomists who agree in the general sentiment that the arteries are muscular.

Thus, Haller believed that muscular fibres were most abundant in the large arteries, while J. Hunter thought the reverse.

Hunter appears to have investigated this subject with great attention, and supposed the muscular substance, in the composition of arteries, to be interior, and the elastic matter exterior; that in large arteries this muscular substance is very small in quantity, and gradually increases in proportion as the artery diminishes in size. He, however, observes, that he *never could discover the direction of the muscular fibres.**

When the great talents of Mr. Hunter as an anatomist are considered, this circumstance cannot fail to excite a belief that the existence of these fibres is not certain: and if to this be added the fact, that even the red-coloured substance of the arteries is elastic, and in that respect different from muscular substance, the reasons for doubting must be increased.

Bichat appears to have entertained very strong doubts on the subject; but he stands almost alone; for a large number both of the preceding and contemporary anatomists, seem to have adopted the sentiment, that *the arteries have a muscular structure.*

The student of anatomy can very easily examine this subject himself, by separating the coats of arteries into different lamina; and by viewing the edges of the transverse and longitudinal sections of those vessels. While thus engaged with this question, he will read with great advantage what has been written upon it by Mr. Hunter, in his treatise on the blood, &c., (see chapter second, section 3.) Bichat ought also to be read upon this subject, which he has discussed in his *Anatomie Generale—Systeme Vasculaire a Sang Rouge*, article *Troisieme*, &c.; and also in his *Traite des Membranes*, article *Sixieme.*

The belief of the irritability of arteries does not, however, rest upon the appearance of their fibres.

1. It is asserted by very respectable authors,† that they have

* Treatise on the Blood, &c. vol. i. p. 113. Bradford's edition.

† See Soemmering on the Structure of the Human Body, vol. iv. German edition. Dr. Jones on the Process employed by nature for suppressing Hemorrhage, &c.

been made to contract by the application of mechanical and of chemical irritation, and also of the electric and galvanic power.

2. A partial or local action of arteries is often produced by the local application of heat and rubefacients, as has been already observed.

3. Arterial action is often suspended in a particular part by the application of cold. It has also been observed that the arteries have for a short time ceased to pulsate in cases of extreme contusion and laceration of the limbs.*

4. When arteries are divided transversely in living animals, they often contract so as to close completely the orifice made by the division.

5. In a horse, bled to death, it was ascertained by Mr. Hunter, that the transverse diameter of the arteries was diminished to a degree that could not be explained by their elasticity. He also found that, after death, the arteries, especially those of the smaller size, are generally in a state of contraction, which is greater than can be explained by their elasticity: for if they are distended mechanically, they do not contract again to their former size, but continue of a larger diameter than they were before the distention; although their elasticity may act so as to restore a very considerable degree of the contraction observed at death.

The contraction, which is thus, done away by distention, Mr. Hunter supposed to have been produced by muscular fibres: for if it had been dependent on elasticity, it must have reappeared when the distending power was withdrawn.

It therefore seems certain, that the arteries have a power of contraction different from that which depends upon elasticity; but whether this depend upon muscular fibres superadded to them, or upon an irritable quality in the *ordinary elastic* fibres of blood-vessels, is a question which is not perhaps completely decided.

—The middle coat of the arteries is composed of flat fibres and bundles of fibres, which surround the vessel in a circular di-

* This local suspension of arterial motion by cold, &c. applied locally, is very difficult to explain: as the action of the heart and the elasticity of the arteries appear sufficient to account for the pulsation of the large arteries.

rection. They are now generally believed to be not muscular in their structure, and do not exist in veins. In the ox and the elephant, they are particularly well developed, in both of which I have examined them with attention, but without discovering any evidence of muscularity in their composition. Berzelius has shown that the fibres of the elastic coats of the arteries differ chemically from those of the muscles. Muscular substance is soft and lax, and contains nearly three-fourths its weight of water, and has the same chemical properties as the fibrine of the blood. The substance of the arterial coat is dry and contains no fibrine, and Dr. Hodgkin has observed that its fibres do not present the transverse striæ seen on the muscular fibre. The arteries are eminently elastic, and to this they owe their property of contraction, when they have been distended, beyond the usual dimensions. It is by virtue of this elasticity also, that the arteries retain their tubular form after death, when they are emptied of blood. The reaction of this coat during the intervals of the heart's action, also contributes to render the flow of blood more uniform.—*

The motion of the blood in the arteries appears to depend,

1st, Upon the impulse given to it by the action of the heart.

2dly, Upon the elasticity of the arteries, in consequence of which they first give way to the blood impelled into them, and then react upon it; and

3dly, Upon the power of contraction in the arteries, or their irritability.

In the larger arteries the blood seems to move as it would through an inanimate elastic tube, in consequence of the impulse given by the heart, and kept up by the arteries themselves. In the smaller vessels it seems probable that the motion of the blood depends in a considerable degree upon the contraction which arises from their irritability.

The obvious effect of the elasticity of the arteries is to resist distention and elongation, and to contract the artery to its natural state, when the distending or elongating cause ceases to act. But it must also resist the contraction induced by the muscular

* Weber's Hildebrandt's Anatomie, tome iii. p. 68.—P.

fibres, and restore the artery to its natural size when the muscular fibres cease to act after contracting it, as has been observed by Mr. Hunter.

It seems probable that all the fibres of which the artery consists are nearly, but not completely circular; for it is not certain that there are any longitudinal fibres in the structure of an artery.

The internal coat of these vessels is very smooth, but extremely dense and firm; and seems to be rendered moist and flexible by an exudation on its surface. It adheres very closely to the contiguous fibres of the coat exterior to it, but may be very readily peeled off from them. It is of a whitish colour, and, like the fibrous structure of the artery, is very elastic. Like that substance, also, it is easily torn or broken; and when ligatures have been applied to arteries, it has often been observed that the fibrous structure, and the internal coat have been separated while this external cellular coat has remained entire.

The arteries are supplied with their proper blood-vessels and lymphatics, (*vasa vasorum.*) It is to be observed, that these blood-vessels are not derived from the artery on which they run, but from the contiguous vessels.

These vessels have nerves also, which are rather small in size, when compared with those which go to other parts.

Arteries appear to have a cylindrical form, for no diminution of diameter is observable in those portions of them which send off no ramifications.

When an artery ramifies, the area of the different branches exceeds considerably that of the main trunk. Upon this principle, the aorta and its branches have been compared to a cone, the basis of which is formed by the branches, and the apex by the trunk.*

The transverse section of an artery is circular.

There are no valves in the arteries, except those of the orifices of the aorta and the pulmonary artery, at the heart. The valves

* According to Brussiere the relation of the branches of the aorta to its trunk is as 25 to 16; Helvetius reckons the orifice of the aorta in comparison with its branches as 64 to 71. Lassus.—H.

of the pulmonary artery have been described in vol. i. p. 463, and those of the aorta have an exact resemblance to them, but are rather larger.

The course of the arteries throughout the body is obviously calculated to prevent there exposure to pressure, or to great extension from the flexure of the articulations by which they pass. With this view they sometimes proceed in a winding direction; and when they pass over parts which are subject to great distention or enlargement, as the cheeks, they often meander; and, therefore, their length may be increased by straightening, without stretching them.

Their course appears sometimes to have been calculated to lessen the force of the blood, as is the case with the *Internal Carotid* and the *Vertebral* arteries.

In the trunk of the body the branches of arteries generally form obtuse angles with the trunks from which they proceed. In the limbs these angles are acute.

The communication of arteries with each other is termed *Anastomosis.* In some instances, two branches which proceed in a course nearly similar, unite with an acute angle, and form one common trunk. Sometimes a transverse branch runs from one to the other, so as to form a right angle with each. In other cases, the two anastomosing branches form an arch, or portion of a circle, from which many branches go off.

By successive ramifications, arteries gradually diminish in size, until they are finally extremely small.

The small arteries do not carry red blood, their diameters being smaller than those of the red particles of that fluid, the serous or aqueous part of the blood can, therefore, only pass through them.

Many of the arteries which carry red blood, and of the last mentioned serous arteries, terminate in veins, which are in some respects, a continuation of the tube reflected backwards.*

* Malpighi and Leuenhoek declare, that by the aid of a microscope they have seen arteries terminating in the veins. Haller advances formally his own experience in support of his assertion. Other anatomists have seen, that in blowing into an artery, the air passed into the corresponding veins. Nevertheless, Duverney

Position of the Heart.

—The heart is situated mainly between the sternum and spine; its left ventricle is placed immediately behind and to the inner side of the left nipple; its base is horizontal, and nearly opposite a line drawn horizontally from the junction of the cartilage of the third rib with the sternum. The right auricle is placed so that its free border is a little to the right side of the sternum, between the junction of the third and fourth costal cartilages with that bone. The flattened surface of the heart below, rests upon the bottom of the pericardium, covering the cordiform tendon of the diaphragm. The apex of the heart, formed by the extremity of the left ventricle, is nearly opposite the junction of the fifth rib with its cartilage.

Dimensions of the Heart.

—The heart was said by Laennec, to be of the size of the closed fist of the same subject. But this is a rule upon which little reliance is to be placed. It was found by very accurate observations made by M. Bizot,* on one hundred and fifty-six subjects of different ages of life, from one to eighty, that the heart has no natural limit in regard to size, but increases indefinitely without being diseased, according to the age of the subject. After fifty years, however, the growth is so slow, as to be scarcely noticeable, except it becomes diseased.

—In 18 subjects between the ages of 16 and 29, on the average, the length was 42 lines; breadth 46; thickness, $17\frac{1}{2}$. In 19, between the ages of 50 and 79, the average length was 46 lines; breadth 53; thickness $18\frac{1}{3}$. In females upon the average at the same ages, the dimensions were each about three lines less. The dimensions of the heart are directly in relation to the breadth of the shoulders, and by careful observations made upon sixty-four subjects, consisting of nearly an equal number of each sex,

and some others say, that a particular substance is interposed between the extremities of these vessels. Ruysch, in his Thesauras Anatomicus, VI. No. 73, says, in repletione arteriarum, replentur et plurimum quosque venæ, et vice versa, ita ut impossible videatur præcise dicere quomodo res se habeat. Discours sur l'Anat.—H.

* Mem. de la Société Med. d'Observation de Paris, 1836.—P.

it was found by M. Bizot, that in individuals of middle stature and under, that the heart was absolutely of greater size, than in those who were distinguished for their tallness.

—It has been asserted by Andral,* that the four cavities of the heart, in their natural and healthy state, are as near as may be of equal dimensions; and by M. Beclard,† that the right ventricle as age advances, becomes enlarged in a greater proportion than the left.

—The researches of the same careful observer has shown, that the right ventricle as well as right auricle,‡ and right auriculo-ventricular orifice and pulmonary artery, are larger than the corresponding parts of the left side, at all the different stages of life. The mean dimensions in men, taken from many individuals, between the ages of 15 and 79, are—

Left ventricle,	length,	34 lines,	breadth,	54 lines.
Right	"	37 "	"	82 "

—Mean thickness of the ventricles between same ages.§

Left	at base, $4\frac{1}{2}$ lines,	middle, 5 lines,	near its point, 4 lines.
Right	" 2 nearly,	" $1\frac{1}{2}$ "	" 1 "

—Mean circumferences of the auriculo-ventricular orifices.

Of the left,	(between the same ages, 16 to 79,)	$45\frac{1}{2}$ lines.
Of the right,	"	54 "

—Mean circumference of the orifice of the aorta, and pulmonary arteries, taken opposite the free border of the sigmoid valves.

* Dict. de Med. nouv. ed. tom. viii.—P.

† Lieutaud and Sabatier also, thought the cavities of the ventricles were equal in the healthy state, and that the cavity of the right was enlarged by the respiratory struggles at the time of death. It has been proved, however, long since, by Legallois, that the mode of death has no effect in altering the form of the heart.—P.

‡ The comparative measurements of the auricles have not been taken.—P.

§ The thickness of the septum ventriculorum is about the same as that of the left ventricle, and undergoes the same modifications in respect to age. The columnæ carnæ are not included in the measurement of the thickness of the ventricle.—P.

Of the aorta, (between the same ages,)	$31\frac{1}{4}$ lines.
Of the pulmonary artery, . . .	$32\frac{1}{3}$* "

—The coronary arteries undergo a developement in size, exactly in harmony with that of the heart. In the fœtus, where the thickness of both ventricles seems equal, there is no difference in the size of the coronary arteries. But as the walls increase in thickness, especially that of the left ventricle, these arteries enlarge, and in particular the left. Boyer, H. Cloquet and others, have fallen into error, in stating that the calibre of the left coronary artery is less than the right.

—Circumference of the coronary arteries at their origin.

General mean of the left in man,	$5\frac{1}{2}$ lines.
" " right "	$4\frac{1}{3}$ "

—The thickness of the ventricles, which are at birth nearly the same, go on increasing, as life advances, though not in equal proportions. The walls of the right ventricle are arrested in the healthy state at their maximum of thickness, much sooner than those of the left.

—The volume of the heart, and the greater or less capacity of the right ventricle, have, in the healthy state, but little influence over the thickness of its walls. Its thickness, however, is found slightly increased in advanced age. That of the left ventricle increases without cessation. Hence, the assertion of Andral and others, that the natural thickness of the walls of the left ventricle is three or four times as great as that of the right, is applicable only in advanced life.

—Professor Cruveilhier has asserted, that the thickness of the ventricles beyond which only hypertrophy is to be considered as existing, are seven to eight lines for the left, and four to five lines for the right. The numerous and careful measurements of M. Bisot, have, however, proved this standard to be excessive, and

* In the latter ages of life, the aorta increases in its dimensions so as to exceed in its circumference at its orifice, the pulmonary artery. This is in all probability owing to the frequency of the morbid alterations of the aorta in old men, in which the middle coat of the vessel loses its elasticity and becomes dilated: while alterations of the pulmonary artery are very rare, even at the most advanced stages of life.—P.

that a thickness of seven lines of the left ventricles in man, and six in women, would be a commencement of hypertrophy, even in the last stages of life; and that the maximum of thickness in the right ventricle, from 50 to 79 years, in man is but $2\frac{1}{9}$th lines, and but $1\frac{1}{4}$ line in woman.

—Mean dimensions of the aorta, taken from a large number of subjects at seven different points.

—One line on the cardiac side of the arteria innominata.

	Men.		Women.
General mean of circumference, from 16 to 79,	33 lines.	Do. from 16 to 89,	31 lines.
Near the left subclavian, general mean,	33 "	"	24 "
Opposite the remains of the ductus arteriosus,	25 "	"	23 "
Above the cœliac artery,	$22\frac{1}{3}$ "	"	$20\frac{1}{2}$ "

—In all the measurements of the heart and other portions of the vascular system, we shall speak only of the healthy or normal measurements at the different stages of life.

Below the renal arteries,	$17\frac{1}{2}$ lines.	In women,	16 lines.
Near its bifurcation,	17 "	do.	15 "

—The diameter of the aorta is greater, as will be seen by these measurements, both in the male and female, near the origin of the innominata, than at its connexion with the heart. It is less near the left subclavian, diminishes considerably near the cœliac and renal branches, and from thence to its termination, scarcely varies at all. These results, also disprove the assertion of Richerand, that the descending aorta and iliac arteries,* are larger in woman than in man. In woman, the internal iliacs continue to increase in size even after the age at which the function of reproduction has ceased. In fact, the whole aortic trunk, like the heart, continues to increase gradually in size in both sexes, up to the most advanced period of life, and like the heart also, as it increases in calibre, has the thickness of its walls likewise augmented.†

* See (further on) measurement of iliac.—P.

† See Richerand's Physiology, 10th edit.

—The branches of the aorta both in regard to size and age, undergo corresponding changes with the aorta itself. Of the abdominal branches, the superior mesenteric is the largest of all; the next in size are the renal and cœliac; the two latter being nearly of the same size. Hence, each kidney receives as much arterial blood as the liver, spleen, and stomach together, as would seem to be rendered appropriate by the relative functions of the organs; that of the kidneys being to depurate the blood of its saline and many other noxious principles.

—Of all the organs in the body, the heart and arteries are the only ones which constantly increase in dimensions; in old age the muscles become atrophied, the skin shrivels, and even the skeleton diminishes in bulk.

Form of the Arteries.

—Bichat and Richerand have considered every arterial tube to be evenly cylindrical, the diameter of which was only diminished when branches were sent off. Beclard believed that they have the form of a truncated cone, with the base turned towards the heart, some of which, as the carotids, for example, being enlarged at the place of division. Others believe with Professor Horner,* "that the arterial system in its general configuration may be compared to a tree, the trunk of which is attached to the heart, and which, by a continued succession of divisions and subdivisions reaches to every part of the body. There are no means of estimating rigidly the collective area of the branches in proportion to that of the trunk; but a little observation on the size of the primitive branches, will satisfy one of a great excess on the part of the latter, and as the rule is maintained throughout, there must finally be an immense disproportion. We have then reason to believe, that if all the branches were assembled into a single cavity, this cavity would be somewhat like a cone, the apex of which would be next the heart. The same rule holds in regard to the venous system, it being observed, however, that the

* A Treatise on General and Special Anatomy, vol. ii. p. 155, by W. E. Horner, Prof. of Anat. University Penn., &c. &c.; fourth edition.—P.

latter has two trunks connected with the heart instead of one. The general rule is therefore established throughout the vascular system, that the collective area of the branches is always greater than that of the trunk from which they proceed. By the same rule the circulation in the branches must be more languid than in the parent trunks, as this circulation is retarded both by additional friction, and by having to fill up a larger canal."*

—Nevertheless, Professor Horner, gives a computation made by Mr. Erskine Hazard, from actual measurement of the arteries, from which it appears, that in many of them at least, the area of the large trunks before subdivision is greater than that of their divided branches united, and consequently that the blood must flow faster through the branches than through the primitive trunk, as the same quantity of blood must be disposed of in the same space of time; and that by this means, friction is reduced, as there is less surface of the vessels exposed to the passing of the blood, and thus the force of the heart's action is continued much farther through the system.

—This manifest discrepancy among anatomists of high reputation, is explicable by the facts made known from careful measurement by M. Bizot; viz. that all the different modes of form specified, and some others, are met with in the arterial system, and that each artery, so to speak, has its peculiar and constant form in a healthy state; the corresponding arteries of the two sides of the body, being analogous in form. To establish the truth in regard to these points, this writer measured 2,162 arteries, beside the measurements of the aorta already given.* All the modes of formation of the arteries he reduces to the five following.

1. A cone, the base of which is directed towards the heart, met with 39 times in the 100.

2. Two truncated cones opposed by their truncated summit, met with 28 times in the 100.

3. A cone with its summit directed towards the heart, met with 14 times in the 100.

4. A perfect cylinder, met with 12 times in the 100.

* It has been computed that the blood flows 5,233 times slower in the capillaries than in the aorta.—P.

5. Two truncated cones opposed by their base, met with 5 times in the 100.

—It is seen by this statement that, contrary to the opinion of most anatomists, the perfect cylinder is one of the rarest forms. The arteria innominata belonged to the second class, or in other words, formed a tube narrowed in its middle, in nearly one half of the cases in which it was examined. The primitive carotid belonged to the same, in more than three-fourths: whilst the same arteries but twice in one hundred and thirty-six instances presented the form of a cylinder.

—The brachial, primitive and external iliacs, belonged also to the second class in about one-third of the cases examined. In the other arteries that form is much more rare. The vessels which present the cylindrical form most frequently, are the radial and crural arteries. The first form, that of a truncated cone, with the base to the heart, is by far most frequent in the arteries of the limbs. The popliteal, however, always presents the fifth form, that of two truncated cones opposed by their bases, or in other words is expanded in its middle at the place where popliteal aneurism usually occurs.

Of the Capillaries.

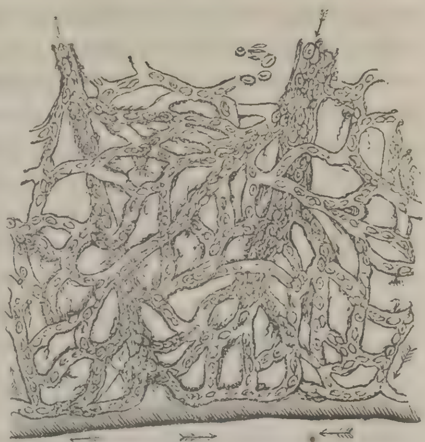
—The extreme ramifications of the arteries, constitute the capillary blood-vessels, which are intermediate to, and form the connexion between the arteries and veins, and may be considered as the radicles of the latter vessels. The extreme minuteness and delicacy of structure of the capillary vessels, are too great to admit of any very rigid scrutiny into the structure of their walls, but it is considered probable that the internal coat of the arteries, is extended through them, so as to be continuous with that of the veins. The capillary vessels, were at one time considered as having other terminations besides those which connected them with the arteries, on one hand, and the veins on the other: some were considered, as opening directly into, and thus forming the secretory ducts of the different glands; others as terminating in like manner, so as to form an imaginary system of vessels, called the exhalents, in the skin, and the different

serous and mucous membranes; and others, according to Lond and Lepelletier de la Sarthe, as terminating in the midst of the different tissues, so as to allow the molecules of blood to escape naked among the organized parts, for the purposes of nutrition. It is now, however, pretty generally admitted, that the capillaries have no termination but by their anastomoses with each other, and their communication with the arteries and veins; that all the fluids which pass from them, for the purposes of nutrition, secretion, or exhalation, permeate in some manner their delicate coats, by an action, somewhat like the exosmosis of Dutrochet. —The direct communication between the arteries and veins, is readily shown by the facility with which the veins may be distended, by injection of the arteries of the extremities with mercury. In many of the viscera, also, it is not unusual to fill some of the veins, when distending the arteries with size injection. —Some anatomists (*vide* note, p. 198-9) assert that they have in the human subject, been able to trace with the microscope, the direct continuity of the arteries with the veins. This may be done more readily in the inferior animals, especially in the reptilia, where the globules of the blood are three or four times larger than those of man.

—In a dissection of a python from South America, and of a boa constrictor from the East Indies, made jointly by the late Dr. Jno. P. Hopkinson and myself, an account of which was read before the American Philosophical Society in 1833, we were enabled by the aid of the mercurial pipe and column, to pass mercury, in many instances, from a branch of the aorta, into the small arteries of the peritoneal investment of the oviducts; and by gently pushing the minute columns of mercury forwards through these, with the handle of a scalpel, it passed through the capillaries into the veins, and the globules of mercury were readily forced in a retrograde direction to the vena cava. In these cases, when distended with mercury, the capillary vessels were very obvious without the aid of a microscope. In the transparent parts of animals, as in the mesentery, in the fins of some fishes, and in the web of a frog's foot, the microscope exhibits very clearly the capillary system of vessels, and the

series of blood globules which pass through them from the arteries to the veins.

Fig. 67.



—Fig. 67, is a representation, after Thomson,* of the appearance of the capillary circulation in the web of a frog's foot. The arrows indicate the course of the blood, the globules of which are seen in these vessels arranged in a linear series.

—Marshall Hall, considers the capillary system as a distinct portion, reticular in its structure, the branches anastomosing and separating from each other, and yet unlike either the arteries or veins, retaining always the same diameter. In the lungs he considers this system particularly well developed, and that the walls of the ultimate branches of the arteries and veins are abruptly terminated, and appear cribriform under the microscope, when they communicate with or divide into the capillary arteries and veins.

—These delicate capillary vessels of the lungs are inclosed in the mucous membrane, forming the bronchial cells. The mucous membrane of these cells being derived from the bronchia, is of course continuous throughout the lungs, and may be regarded as a delicate membrane filled with a net-work of capillary vessels, formed into cells, for the purpose of allowing an extensive superficies to be comprised in a small space: upon one surface of this membrane, the pulmonary vessels maintain a stream of blood, divided into currents of the minutest size; and on the other, air is admitted through the bronchia, the oxygen of which acts upon the particles of blood in their most divided state.

* Circulation—Cyclop. of Anat. and Physiology.—P.

—The pulmonary or lesser circulation, (which is conducted through the pulmonary arteries and veins,) would be perfectly isolated from the greater or systemic, (that of the aorta and vena cava,) were it not that the bronchial arteries anastomose in the lungs with the smaller branches of the pulmonary.

—The capillary vessels are so abundant, that the spaces left between them are believed in man to be less than the diameter of the vessels themselves. Their diameter has been measured by the aid of the microscope, after the vessels had been minutely injected, and has been found to vary in different parts of the body. The mean of their measurement, according to Müller, is between the $\frac{1}{3700}$th and $\frac{1}{1850}$th part of an inch. No other tubes in the body are so minute as the capillary vessels, even those of the kidney or testicle.

Action of the Heart and Arteries.

—The heart of an adult man, in the middle period of life, contracts from seventy to seventy-five times a minute. At each pulsation it is calculated that two ounces of blood is ejected. The whole amount of blood in the human body has been variously estimated, and it is perhaps impossible to arrive at a very accurate conclusion upon the subject; there is certainly a larger amount in the body than is usually at one time in active circulation, a part of it moving slowly, or remaining stagnant for a time, in the capillaries of some portions of the body. According to Wrisberg, one woman lost by a fatal flooding, 26 lbs. of blood; and in another plethoric woman, who was beheaded, 24 were collected. Herbst* has calculated that there is usually about 10 lbs. of blood in circulation in the human body. It may, therefore, be admitted with some certainty, that the circulation of the entire mass of blood may take place in from one to two minutes.

—The frequency of the heart's action diminishes gradually from the commencement to the end of life, thus:†

In the embryo, the number of beats in a minute is	150
Just after birth, - - - -	130 to 140

* Herbst. De Sang. Quant. etc. Goettingen, 1822.

† Müller's Physiology, (Bennet's translation,) p. 171, vol. i.

During the first year, - - -	115 to 130
During the second year, - -	100 to 115
During the third year, - - -	90 to 100
About the seventh year, - - -	85 to 90
About the fourteenth year, - - -	80 to 85
In the middle period of life, - -	70 to 75
In old age, - - - - -	50 to 65

—In persons of sanguine temperament the heart beats somewhat more frequently than in those of the phlegmatic, and in the female sex more frequently than in the male. The number of pulsations in the minute vary very much in different animals; it is as low as 40 in the horse.

—The contraction (systole) of the heart, is its only active state; its dilatation (diastole) is effected passively during the moment of repose when the fibres are relaxed, by the blood which is poured into its cavities from the contiguous veins. Dupuy, a distinguished veterinary surgeon of Frankford, found, on introducing his hand into the abdomen of a living horse, that the vena cava ascendens becomes turgid during the systole of the heart; and flaccid during the diastole, in consequence of the blood rushing from the veins into the cavities of the heart. The apex of the heart is closely in contact with the ribs, from which it is separated only by the pericardium. The body of the heart is also near the inner surface of the ribs and sternum; for there is nothing intervening beside the pericardium but a thin prolongation of the pulmonary tissue. The *impulse of the heart, pulsis cordis,* is owing to the shock communicated to the walls of the thorax in the neighbourhood of the fifth and sixth ribs, and which is *believed* to take place during contraction, by the apex of the heart being tilted upwards and forwards. This impulse must not be confounded with the arterial pulse or *proper sounds of the heart,* though it is synchronous with the first sound.

—The *sounds of the heart* are twofold; the first sound and the stronger, is produced by the quick successive contraction of the auricles and ventricles. The second sound, as results from the recent observations of Dr. Carswell, is produced by the sudden closing under the elastic reaction of the arteries, of the semilunar

18 *

valves of the aorta and pulmonary artery. The interval between these sounds is very slight; it is calculated by Müller to be about the fifth part of a second.

—The pause which intervenes between the termination of the second and the recommencement of the first, is nearly equal to the period which elapses between the pulsations of the arteries.

Of the Pulse.

—The blood not being able to escape from the arteries into the veins through the capillaries, as quickly as it is injected into the former by the heart, it necessarily exerts a pressure on the elastic coat, which yields both in the direction of its length and its diameter. This elastic yielding constitutes the arterial throb or pulse. This pulsation is not produced, however, *directly*, by the two ounces of blood injected that moment from the heart; but indirectly, in consequence of these two ounces injected into the base of the column of blood, with which the aortic system is filled and the transmission of the shock through the whole arterial system driving out at the other extremity a corresponding quantity into the veins. The impulse of the heart is transmitted by the oscillation of the particles, along the vessels, (precisely as takes place when a shock is communicated to a column of water in a hose,) and this constitutes the pulse. The elastic force of the arteries when distended is very familiar to those who are in the habit of injecting them for anatomical study. By partially filling the vessels with a thin fluid and then throwing in more fluid by jerks, we may readily produce a sort of artificial pulse.—

Of the Veins.

These tubes, which return to the heart the blood carried from it by the arteries, are more numerous than the arteries, and often are larger in diameter.

They generally accompany the arteries, and very often two veins are found with one artery. These are called the *venæ comties.*

In addition to these last mentioned veins, which may also be called *deep-seated*, there are many subcutaneous veins which appear on almost every part of the surface of the body.

The capacity of all the veins is therefore much greater than that of all the arteries.

Those subcutaneous veins which are of considerable size, communicate very freely with each other, and also with the deep-seated veins.

The trunks of the veins, in those places where no branches go off, are generally cylindrical. There are, however, some exceptions, in which these vessels are irregularly dilated, as sometimes happens in the case of the internal jugular vein. It is, however, not easy to determine from the appearance of veins injected after death, respecting their situation during life, as their coats are very yielding; and it is very probable that they are, therefore, preternaturally dilated by the injection.

Veins, directly or indirectly, originate from the termination of arteries: but they do not pulsate as the arteries do, because the impulse given to the blood by the heart is very much diminished in consequence of the great diminution of the size of the vessels through which the blood has passed.

In some cases, however, when blood flows from an opened vein, the extent of its projection is alternately increased and diminished, in quick succession, as if it were influenced by the pulsation of the heart.

The *Coats of Veins* differ considerably from those of *Arteries*,—for they are *thinner*, and so much less *firm*, that veins, unlike arteries, collapse when they are empty.

They consist of a dense elastic substance, the fibres of which are much less distinct than those of arteries, but some of them are to be seen in a longitudinal direction. *These fibres can be made to contract by local irritation;* for if a vein be laid bare in a living animal, and then punctured, it will often contract so as to diminish its diameter very considerably, although no blood shall have escaped from the punctures.

Next to the elastic substance is the internal coat, which is smooth and polished. It is separated from the substance exterior to it with difficulty, although it may be taken from it very easily in the vena cava.

This internal coat is more ostensible than the internal coat of arteries, and is not, like the latter, disposed to ossification. It is

frequently so arranged as to form valves, which are plaits or folds, of a semilunar form, that project from the surfaces into the cavities of these vessels.*

Two of these valves are generally placed opposite to each other; and, when raised up, they form a septum in the cylindrical cavity of the vessel. The septum, thus composed, is concave towards the heart, (see Fig. 66, p. 191.)

The valves have a great effect in preventing the contents of the veins from moving in a retrograde course: they therefore necessarily modify the effects of lateral pressure, in such a manner, that it propels the blood forward, or to the heart.

These valves are generally found in the veins of the muscular parts of the body, especially in those of the extremities. They are not found in those veins which are in the cavities of the body, nor in the internal jugulars. They are placed at unequal distances from each other.

The coats of the veins are somewhat transparent; and therefore those veins which are subcutaneous have a bluish aspect, which is derived from the colour of the blood they contain.

The colour of the blood in the veins is different from that in the arteries, being of a darker red.

The situation and arrangement of the large trunks of veins is much alike in different subjects; but the branches, especially those which are subcutaneous, are very variable in their situations.

Of the Blood.

The blood of a healthy person indicates a tendency to coagulate very soon after it is discharged from the vessels which naturally contain it, although it is perfectly fluid in those vessels.

If it remain at rest, after it is drawn from the vessels, it soon coagulates into a solid mass, of a soft texture. From this solid mass a fluid is soon observed to issue, which appears in very

* The valves of the veins were first described by Charles Etienne of Paris, in 1546. In 1547, Amatus, a Portuguese, saw at Ferrara, those at the mouth of the vena azygos. Sylvius, of Paris, announced them about the same time in the jugular, brachial and crural veins. Fabricus ab Aquapendente claims the discovery for himself in 1574. Lassus.—H.

small drops on almost every part of the surface. These drops quickly increase and run together, and in a short time the fluid surrounds the solid mass, and exceeds it in quantity.

The solid part which thus appears upon the spontaneous separation of the blood, is denominated *Crassamentum* or *Cruror;* the fluid part is called *Serum.*

The substance which contains the red colour of the blood, remains with the *Crassamentum.* The *Serum,* when it separates without agitation, is free from the red colour.

The colouring matter may be separated completely from the *Crassamentum* by washing it with water.

The blood, therefore, consists of three parts, namely; the *Serum ;* the *substance which coagulates spontaneously* (*fibrine*) *;* and *the Colouring Matter.*

—If the blood be examined with the microscope in the vessels of a transparent part, or immediately after it has flowed from the body, it is seen to consist of small red *particles* or *globules,* and a clear colourless fluid. This fluid is the *lympha* or *liquor sanguinis,* and must not be confounded with the serum, which separates from the crassamentum during coagulation. It can be obtained free from the red globules, before coagulation takes place, by filtering the blood of a frog or some other animal, in which the red globules are so large as not to pass through the pores of the filtering paper. The liquor sanguinis, consists of the serum of the blood that holds the fibrine, which is also colourless, in a state of solution. When the fibrine coagulates, it encloses within it the red particles, and the watery part of the blood (*serum*) is left, which holds the albumen in solution.—

The Serum

Has a considerable degree of consistence, although it is much thinner than blood. In its perfectly natural state, it is almost transparent, and appears to be very lightly tinged with a greenish yellow colour ; but it is very often impregnated with a portion of bile, which is probably carried to the blood-vessels by the absorbents. It contains a large quantity of albumen, or matter like the white of an egg. If heated to 140° of Fahrenheit, it be-

comes opaque; and when the heat is increased to 156° or 160,° it is firmly coagulated. It is also coagulated by alcohol, by mineral acids, and by rennet.* It is proved by chemists, that it contains a small quantity of pure soda. It therefore changes several of the blue colours of vegetables to green. It is also found to contain a similar quantity of the muriate and the phosphate of soda and the phosphate of lime. These saline substances were discovered by diluting serum with water, and exposing the mixture to heat, by which the albumen was coagulated into flocculi; these flocculi were separated by filtration; the liquor was then diminished by evaporation, and the salts obtained from it by crystallization.

Serum likewise contains a portion of sulphur combined with ammonia.

When it is exposed to a coagulating heat, a small portion of it remains fluid.

This fluid portion has been supposed to contain a considerable quantity of gelatine; but it is contended by Mr. Brande,† that *Gelatine* does not exist in the serum of the blood, and that this portion consists of albumen combined with a proportion of alkali.

It is also asserted by Dr. Bostock,‡ one of the latest writers on the subject, that the serosity of blood, (the term applied to the last mentioned fluid,) contains no gelatine; but that, with a minute quantity of albumen, it consists of a large portion of an animal matter, which is different either from gelatine or albumen, being unlike either of them, in its chemical qualities.

The Crassamentum

Is rendered very different in its appearance, by the different circumstances in which it may coagulate.

When the blood remains at rest immediately after it is drawn,

* See Hewson, vol. i. 139.—I suspect that some particular management is necessary in the use of rennet.

† In his Researches on the Blood, communicated to the Royal Society of London, in 1812, and republished in the Eclectic Repertory, for April, 1813.

‡ See his Observations on the Serum of the Blood, in the Medico-Chirurgical Transactions, vol. ii. republished in the Eclectic Repertory, for October, 1812.

the crassamentum which forms in it is a concrete substance, without the smallest appearance of fibre in its composition. If the blood is stirred with a rough stick, while it is flowing from an animal, a large portion of it will concrete upon the stick in a fibrous form, so as to resemble a mass of entangled thread, some of the red colouring matter still adhering to it.

The crassamentum, in either of these forms, may be washed perfectly white; the red colouring matter passing completely away with the water. In this state it appears* to have all the chemical properties of the fibrous matter of muscular flesh. It also resembles the gluten of vegetables, being soft and elastic. The name FIBRINE is now generally applied to it.

If FIBRINE is washed and dried, its weight is very small indeed when compared with that of the blood from which it has been obtained. It is, therefore, probable that a considerable proportion of the bulk of the crassamentum, as it forms spontaneously, depends upon the serum which exists in it, and can be washed away.

The spontaneous coagulation of the blood, which appears to depend principally upon the *Fibrine*, may be prevented by the addition of several foreign substances to the blood, when it is drawn. It is subject to great variations that depend upon the state of the body at the time of bleeding; and in some conditions, it does not take place at all.†

In a majority of dead subjects the blood is found more or less coagulated in the veins; but in some subjects it is found without coagulation. It is asserted that it does not coagulate in subjects who have died suddenly, in consequence of anger, lightning, or a blow on the stomach.

The Colouring Matter.

When the blood-vessels in the transparent parts of certain liv-

* By the experiments of Mr. Charles Hatchett, published in the London Philosophical Transactions for 1800.

† See an Inquiry into the Properties of the Blood, by the late William Hewson: and Experiments by his son, T. T. Hewson, in the Eclectic Repertory, Jan. 1811. See, also, a Treatise on the Blood, &c. by the late J. Hunter.

ing animals are examined with magnifying glasses, it appears that the red colour of the blood is owing to bodies of a globular form, which are diffused through a transparent fluid. The appearance of these bodies has been examined, with, great attention, by many physiologists, since the publication of Leuenhoeck, in the London Philosophical Transactions.*

Several of these gentlemen have described the appearance of the blood very differently; but Haller, Spallanzani and J. Hunter agree that the figure of the red particles is globular.† Hunter observes farther, that the red globules do not run into each other as two globules of oil would do when divided by water; and he believes that they cannot unite. At the same time they seem not to have the properties of a solid: for when circulating in the vessels, they assume elliptical forms, adapting themselves to the size of the vessels. They also excite no sensation of solidity when touched.

They appear to be more heavy than the other parts of the crassamentum: for in healthy blood the lower part of the mass contains more of the colouring matter than the upper part; and in the blood of persons who labour under acute local inflammation, they often subside completely from the upper part; and thus

* Among the most distinguished of these observers were Father De la Torre, Haller, Hewson, Fontana, Spallanzani, J. Hunter, Cavallo.

Some short accounts of Leuenhoeck's original observations on the Blood are to be found in the Philosophical Transactions of London, for 1664, in the fasciculi which are numbered 102 and 106. A more full description is contained in Boerhaave's Academical Lectures on the Theory of Physic. See the section on the nature of the blood.

The glasses of Father De la Torre were transmitted from Naples to the Royal Society of London in 1765. They were accompanied by a letter from Sir F. H. E. Stiles, to which are subjoined some observations by the Rev. Father himself. The letter and the observations are published in the 55th volume of the Transactions of that society.

In the year 1798, Tiberius Cavallo published an Essay on the Medicinal Properties of Factitious Air, with an Appendix on the Nature of the Blood, in which is contained a farther account of the glasses of De la Torre.

† I believe that this is also the opinion of Fontana.—In J. Hunter's work on the blood there are some interesting observations on microscopical deceptions. See the note commencing in page 39, Bradford's edition.

occasion what is called by Mr. Hewson *the inflammatory crust*, or *size*.

It has been observed by Mr. Hewson, and also by Mr. Hunter, that the globules do not retain their form in every fluid. They are said to be dissolved very quickly in water, and then they form a fine clear red. Several of the neutral salts, when dissolved in water, prevent the solution of the globules. Mr. Hunter informs us, that the vitriolic acid, when greatly diluted, does not dissolve them, &c. The muriatic acid, when three times as strong as vinegar, destroys their colour without dissolving them, although when more diluted, it dissolves them.

—Hewson described the red globules as being flattened, and was the first to discover distinctly, the dark spot in the centre, formed by the central nucleus. Modern improvements in the manner of using the microscope, have confirmed his views, and shown that the globules of blood in different animals, are always flattened, and that they vary in their outline, from the elliptical to the circular form.

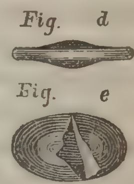
Fig. 68.*

—In the mammalia, including man, they are circular disks; that is, globules flattened upon the sides. In birds, reptiles, and fishes, they are elliptical; the long diameter being twice that of the transverse. In the globules of human blood, their thickness is about one-fourth or one-fifth of their transverse diameter. The size of the red globules varies very much in different animals, and to some extent among themselves, even in the same animals. But in man and most other animals, the variation in size, never amounts to a doubling of the diameter. The size of the red globules in the amphibia, is greater than in any other class of animals. The long diameter of the red globules in the frog, is four times that of the circular diameter of those of man. The diameter of the red particles in man have been variously stated, from the $\frac{1}{3000}$th to the $\frac{1}{5000}$th part of an English inch.

* Fig. 68. *a*, Globule of human blood. *b*, Of sheep's blood. *c*, Of the blood of a sparrow. These globules are magnified a thousand times in diameter.—P.

—In the centre of all the red particles there is a dark spot, which is elliptical in shape, in all animals in which the general shape of the particle is elliptical; and round in those in which the particles are circular and flattened. These spots or *nuclei*, when viewed with the light in a particular situation, reflect it, and present the appearance of holes, which at one time induced the belief, that the particles were annular in shape. Most of the recent microscopical observers have satisfied themselves of the correctness of Hewson's opinion, that the dark spot in the centre, is owing to the presence of a solid nucleus in each particle. The outer vesicle, which encloses the nucleus, is seen torn, (see Fig. 70,) showing the nucleus in one of the red particles of the frog.

Fig. 69.*



—These vesicles contain the colouring matter of the blood, and under particular treatment, are rendered soluble, and the naked nuclei are precipitated in the form of minute granules. Under any treatment, the latter are found to be insoluble.

Chyle Globules.

—In the blood, Hewson also observed some minute globules, which he considered those of the chyle. They have since been observed by Müller and others. They are abundant in the chyle, in the lymph, and are probably, as Hewson suggested, identical with the nuclei of the red particles. According to Prévost and Dumas, their diameter is precisely the same as that of the primitive muscular fibre, the $\frac{1}{7196}$th part of an inch.—

The colour of the blood has, for a long time, been supposed to depend upon iron. About the middle of the last century, Vicentius Menghini published in the Transactions of the Academy of Sciences of Bologna, an account of experiments which contributed to establish this sentiment. In this account he stated that, after washing the colouring matter from the crassamentum,

* Fig. 69. *d*, Globule of frog's blood, magnified seven hundred times, and seen in profile. *c*, Front view of the same, in which the envelope or colouring matter is torn, so as to exhibit the central nucleus.—P.

he had separated it from the water by boiling; in which case it either rose to the surface of the water, or subsided, and left the water clear. After drying with a gentle heat, some of the colouring matter thus separated, and then repeatedly washing it, he found that it contained a considerable quantity of iron, which was attracted by the magnet.

After exposing a large quantity of the colouring matter to an intense heat, he found in it a small piece of iron, of a spherical form, but hollow; and a powder which was attracted by the magnet, but appeared more like rust of iron than iron filings.

He believes the seat of this iron to be in the colouring matter of the blood, as neither the serum nor fibrine appeared to contain it. According to his calculation, the blood of a healthy man contains more than two ounces of iron.

This doctrine of Menghini has been very generally admitted: and by several chemists of the first character, namely, Bucquet, Fourcroy, Vauquelin, &c.

CHAPTER VIII.

A PARTICULAR ACCOUNT OF THE DISTRIBUTION OF THE ARTERIES.

Of the Aorta, or the Great Trunk of the Arterial System.*

When the heart is in its natural position, the right ventricle is nearly anterior to the left, and therefore, the *Aorta,* where it originates from the left ventricle, is behind the pulmonary artery, and covered by it. Its first direction is so oblique towards the right side of the body, that it crosses the pulmonary artery behind, and appears on the right side of it. It has scarcely assumed this position before its course alters, for it then proceeds obliquely backwards and to the left; so as to form a large curve or arch, which extends to the left of the spine.

The position of this curve or arch is so oblique, with respect to the body, that the cord or diameter of it, if it were extended anteriorly and posteriorly, would strike the cartilage of the second or third *right* rib about the middle of its length, and the *left* rib near the head. In consequence of this position of the curve, the *Aorta* crosses over the right branch of the pulmonary artery, and the left branch of the windpipe: and assumes a situation, in front, and to the left of the third dorsal vertebra: from this situation it proceeds downwards: in front, but rather on the left side of the spine, and in contact with that column.

The *Aorta,* as well as the *Pulmonary Artery,* for a small distance from the heart, is invested by the pericardium; and, when that sac is opened, appears to be contained in it.

After crossing the right branch of the *Pulmonary Artery,* a

* This name was given by Aristotle.—H.

ligament is inserted into it, which proceeds from the main trunk of the pulmonary artery at its division: this ligament was the *Canalis Arteriosus* in the fœtus.

As the *Aorta* proceeds down the spine, it is situated between the two lamina of the mediastinum, and in contact with the left lamen, through which it may be seen. It descends between the crura of the diaphragm, in a vacuity which is sufficiently large to admit of its passage without pressure from the surrounding parts, and is still in contact with the anterior surface of the spine, but rather to the left of the middle of it. It continues this course along the spine until it arrives at the cartilaginous substance between the fourth and fifth lumbar vertebræ, when it divides into two great branches of equal size, which form an acute angle with each other. These are denominated the *Common* or *Primitive Iliac* arteries.

From the *Aorta* in this course are sent off the arteries which are distributed to all the parts of the body for their nourishment and animation.

From the curve proceed the great branches which supply the heart, the head, the upper extremities, and part of the thorax. Between the curve and the great primitive iliac arteries, the *Aorta* sends off those branches which supply the viscera contained in the cavities of the thorax and abdomen,* and part of the trunk of the body. The great *Iliac* branches of the *Aorta* are divided into smaller arteries, which supply the whole of the lower extremities and some of the viscera of the pelvis.

Of the Branches which go off from the Arch of the Aorta.

The proper arteries of the heart, denominated *Coronary Arteries*, proceed from the *Aorta* so near to the heart that their orifices are covered by the semilunar valves, when those valves are pressed against the sides of the artery. These arteries have been described in the account of the heart, (see page 468, vol. i.)

The arteries of the head and of the upper extremities proceed from the upper part of the curve in the following manner.

* It ought to be observed here, that the viscera, in the lower part of the pelvis, receive some branches from the internal iliac arteries.

A large trunk, called *Arteria Innominata*, goes off first. This is more than sixteen lines in length, when it divides into two branches, one of which supplies the right side of the head, and is denominated the *Right Carotid:* the other proceeds to the right arm, and from its course under the clavicle, is called, at first, the *Right Subclavian.* Almost in contact with the first trunk, another artery goes off, which proceeds to the left side of the head, and is called the *Left Carotid.* Very near to this, arises the third artery, which proceeds to the left arm, and is denominated the *Left Subclavian.* From these great branches originate the blood-vessels, which are spent upon the head and neck and the upper extremities.

As these arteries arise from the curve of the *Aorta*, they are situated obliquely with respect to each other. The *Arteria Innominata is not only* to the right, but it is also anterior to the two others: and the *Left Subclavian* is posterior, as well as to the left of the *Left Carotid* and the *Arteria Innominata.*

The Carotid Arteries.

The two carotid arteries above mentioned have been denominated *Common Carotids*, to distinguish them from their first ramifications, which are called *Internal* and *External Carotids.*

The Common Carotids

Proceed towards the head on each side of the trachea: at first they diverge, but they soon become nearly parallel to each other, and continue so until they have ascended as high as the upper edge of the thyroid cartilage, when they divide into the *Internal* and *External Carotids.*

These arteries are at first very near each other, and rather in front of the trachea; they gradually diverge and pass backwards and outwards on the sides of it, and of the œsophagus, until they have arrived at the larynx. In the lower part of the neck they are covered by the sterno-mastoidei, the sterno-hyoidei, and thyroidei, as well as by the platysma myoidei muscles. Above, their situation is more superficial; and they are immediately under the platysma myoides.

On the inside, they are very near the trachea and larynx, and the œsophagus; on the outside, and rather anterior to them, are the internal jugular veins; and behind, on each side, are two important nerves called the *intercostal* and the *par vagum.* These blood-vessels and nerves are surrounded by absorbent vessels.

The *Common Carotid Arteries* send off no branches from their origin to their bifurcation; and they appear to preserve the same diameter throughout their whole extent. In some few instances the right carotid has been found larger than the left. The external and internal branches into which they divide, are nearly equal in the adult; but it is supposed that the internal is the largest during infancy. The relative position of these branches is also different at the commencement from what it is afterwards. The *Internal Carotid* forms a curve which projects outwardly, so as to be exterior to the *External Carotid,* while this last proceeds upwards, and rather backwards.

The External Carotid Artery

May be considered as extending from its commencement, which is on a line with the superior margin of the thyroid cartilage, to the neck of the condyle of the lower jaw, or near it.

At first it is superficial; but as it proceeds upwards it becomes deep-seated: and passing under the digastric and stylo-hyoidei muscles, and the ninth pair of nerves, is covered by the *Parotid Gland.* After this, it again becomes superficial; for the temporal artery, which may be regarded as the continuation of the external carotid, passes over the zygomatic process of the temporal bone.

As the *External Carotid* supplies with blood the upper part of the neck and throat, the exterior of the head and face, and the inside of the mouth and nose; its branches must necessarily be numerous, and must pass in very various directions.

Thus, soon after its commencement, it sends off, in an anterior direction, three large branches; viz. to the upper part of the neck, to the parts within the lower jaw, and to the cheeks and lips. These are denominated, the *Superior Thyroid*, the *Sublingual,* and the *Facial.* It then sends off to the back of the head one

which is called the *Occipital;* and, as it proceeds upwards near the condyle of the lower jaw, another which passes internally, behind the jaw, to the deep-seated parts in that direction. After this, it forms the temporal artery, which supplies the forehead and central parts of the cranium. Besides these larger branches, the external carotid sends off two which are smaller; one from near the origin of the sublingual artery, which is spent principally upon the pharynx and fauces, and is called the *Inferior Pharyngeal:* and another, while it is involved with the parotid gland, which goes to the ear; and is therefore called *Posterior Auris.*

These arteries are distributed in the following manner:

1. *The Superior Thyroid Branch*

Comes off very near the root of the external carotid, and sometimes from the common trunk; it runs obliquely downwards and forwards, in a meandering course, to the thyroid gland, where it is spent. During this course it sends off one branch to the parts contiguous to the os hyoides; another to the neighbourhood of the larynx: and a third branch which may be termed *laryngeal*, that passes with a small nerve derived from the laryngeal branch of the par vagum, either between the os hyoides and thyroid cartilage, or the thyroid and cricoid cartilages, to the interior muscles of the larynx; and finally returns again to terminate externally.

While in the thyroid gland this artery anastomoses with the inferior thyroid, and also with its fellow on the opposite side.

2. *The Lingual, or Sublingual Branch,*

Goes off above the last mentioned artery, and very near it; but in a very different direction, for it runs upwards and forwards, to the tongue. In this course it crosses obliquely the os hyoides, and is commonly within the hyoglossus muscle. It gives off branches to the middle constrictors of the pharynx, and to the muscles contiguous to the tongue. It also sends off a branch which penetrates to the back of the tongue, which is called, from its situation, *Dorsalis Linguæ.* At the anterior margin of the

hyoglossus muscle it divides into two branches, one of which passes to the sublingual gland and the adjacent parts, and is thence called *Sublingual;* while the other branch, the *Ranina,* passes by the side of the genio-glossus muscle to the apex of the tongue.

3. *The Facial or External Maxillary*

Runs obliquely upwards and forwards under the ninth pair of nerves, the stylo-hyoideus muscle and the tendon of the digastric, across the lower jaw and cheek, towards the inner corner of the eye, in a serpentine course. Before it crosses the jaw it sends off several branches, viz. to the pharynx, the tonsils, the inferior maxillary gland and the parts contiguous to it. It also sends a branch towards the chin, which passes between the mylo-hyoideus, the anterior belly of the digastric, and the margin of the lower jaw: and some of its branches continue to the muscles of the under lip. This branch is called the *Submental.*

This artery then passes round the basis or inferior edge of the lower jaw, very near the anterior margin of the masseter muscle, and is so superficial that its pulsations can be readily perceived. After this turn, its course is obliquely upwards and forwards. Near the basis of the jaw it sends off a branch to the masseter, which anastomoses with small branches from the temporal; and another which passes superficially to the under lip and contiguous parts of the cheeks. This last is called the *Inferior Labial.*

After the artery has passed as high as the teeth in the lower jaw, it divides into two branches; which go, one to the under, and the other to the upper lip; that to the upper lip is largest. These branches are called *Coronary.*

The *Coronary Artery of the lower lip* passes under the muscles called *Depressor Anguli Oris,* and *Orbicularis Oris,* into the substance of the lip, and anastomoses with its fellow of the opposite side.

The *Coronary Artery of the upper lip* passes under the zygomaticus major and the orbicularis, and very near the margin of the upper lip internally. It also anastomoses freely with its fellow on the opposite side. These anastomoses are frequently

so considerable that the arteries on one side can be well filled by injecting those of the other. The coronary branches, as well as the main trunk of the facial artery, observe a serpentine or tortuous course; in consequence of which they admit of the motions of the cheeks and lips, which they would greatly impede, if they were straight.

From the upper coronary artery a branch continues in the direction of the main trunk of the facial artery, by the side of the nose, which extends upwards, sending off small branches in its course, and finally terminates about the internal angle of the eye and the forehead.

4. *The Inferior Pharyngeal*

Is a very small artery; it rises posteriorly from the external carotid, opposite to the origin of the sublingual, and passes upwards to the basis of the cranium. In this course it sends several branches to the pharynx, and to the deep-seated parts immediately contiguous.

It also sends branches to the first ganglion of the intercostal nerve, to the par vagum, and to the lymphatic glands of the neck; and, finally, it enters the cavity of the cranium by the posterior foramen lacerum.

In some cases it also sends a small branch through the anterior foramen lacerum.

5. *The Occipital Artery*

Arises from the posterior side of the external carotid, nearly opposite to the facial, but sometimes higher up; it ascends obliquely, and passes to the back part of the cranium, between the transverse process of the atlas and the mastoid process of the temporal bone.

In this course it passes over the internal jugular vein and the eighth pair of nerves, and under the posterior part of the digastric muscle: it lies very near to the base of the mastoid process, *and under the muscles which are inserted into it.* After emerging from these muscles, it runs superficially upon the occiput, dividing into branches which extend to those of the temporal artery.

The *Occipital Artery* sends off branches to the muscles which are contiguous to it, and to the glands of the neck.

It also gives off the following branches; one called the *Meningeal*, which passes through the posterior foramen lacerum to the under and back part of the dura mater: one to the exterior parts of the ear: another which passes downwards, and is spent upon the complexus, trachelo-mastoideus, and other muscles of the neck: and several smaller arteries.

The artery next to be described, is sometimes sent off by the occipital artery.

6. *The Posterior Auricular, or Stylo-Mastoid Artery.*

When it arises from the external carotid, comes off posteriorly from the artery, where it is involved with the parotid gland, and passes backwards between the meatus auditorius externus and the mastoid process. It then ascends, in a curved direction, and terminates behind the ear.

In this course it sends off small branches to the parotid gland, and to the digastric and sterno-mastoid muscles. Sometimes a distinct branch, which is particularly visible in children, passes through an aperture in the meatus auditorius externus, and is spent on its internal surface.

It also sends off a branch which enters into the *Stylo-Mastoid Foramen*, and supplies small vessels to the membrana tympani and the lining membrane of the cavity of the tympanum; to the mastoid cells; to the muscle of the stapes, and to the external semicircular canal. One of these vessels anastomoses in the upper and posterior part of the cavity of the tympanum, with a small twig derived from the artery of the dura mater. When it has arrived behind the ear, the *Posterior Auricular Artery* terminates upon the external ear and the parts contiguous to it.

Distribution of the Branches of the External Carotid Artery, after Sir Charles Bell. (*See Plate facing page* 228.)

A. The *Common Carotid Artery.*
B. The *Internal Carotid Artery*, or Artery of the Cerebrum.
C. The *External Carotid Artery.*

D. The *Lower Thyroid Artery*, being a branch of the Subclavian Artery.
E. The *Upper Thyroid Artery*, being the first branch of the Carotid.

Branches of the External Carotid Artery.

1. The *Lingual Artery.*
2. The *Facial Artery* or *Labial Artery.*
3. The *Submental Artery.*
4. The *Upper* and *Lower Coronary Arteries.*
5. The *Inosculations* of the extreme Branches of the Facial Artery, with the *Ophthalmic Artery.*
6. The Occipital Artery.
7. The place where it frequently sends down inosculations to the vertebral artery.
8. The Lesser Posterior Artery of the Ear.
9. A Branch sometimes called Posterior Temporal Artery.
10. Posterior Artery of the Ear, or Stylo-mastoid.
11. The continued Branch of the External Carotid, sometimes called the Temporal Artery; it divides into the submaxillary and proper temporal artery.
12. The *Internal Maxillary Artery.* See the distribution of this artery in the next Plate, Fig. I. 14, and Fig. II.
13. The *Transverse Artery* of the Face.
14. The *Temporal Artery*, dividing into anterior and posterior temporal arteries. There are other branches less superficial. The deep Temporal is a branch of the Internal Maxillary.

7. *The Temporal Artery*

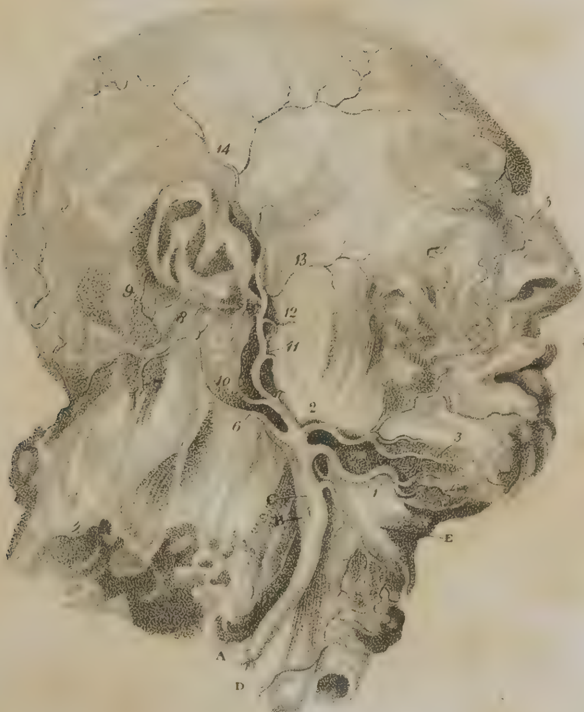
Is considered as the continuation of the external carotid, because it preserves the direction of the main trunk; although the internal maxillary is larger.

After parting with the internal maxillary it projects outwards; and passing between the meatus auditorius externus and the condyle of the lower jaw, continues upwards, behind the root of the zygomatic process of the temporal bone, to the aponeurosis of the temporal muscle: on the outside of which, immediately under the integuments, it divides into two large branches denominated *anterior* and *posterior*.

Before this division the temporal artery sends off several branches of very different sizes.

One, which is considerable in size, and called the *Transverse*

Plate III.



Facial Branch, advances forwards across the neck of the condyle of the lower jaw, and giving small branches to the masseter, runs parallel to the parotid duct, and below it. This branch is spent upon the muscles of the face, and anastomoses with the other vessels of that part.

The temporal gives off small branches to the parotid gland and to the articulation of the jaw. From the last mentioned branch small twigs pass to the ear, one of which enters the cavity of the tympanum by the glenoid fissure.

While this artery is on a line with the zygoma, it sends off a branch called the *middle temporal artery*, which penetrates the aponeurosis of the temporal muscle, and ramifies under it upon the muscle in an anterior direction.

The two great branches of the temporal artery are distributed in the following manner. The *Anterior* passes up in a serpentine direction on the anterior part of the temple, and supplies the front side of the head and the upper part of the forehead.

The *Posterior* extends upwards and backwards, and supplies the scalp on the lateral and middle part of the cranium, and also the bone.

Ramifications from each of these branches anastomose on the upper part of the cranium with those of its fellow of the opposite side. The anterior branch also anastomoses on the forehead with the facial and ophthalmic arteries; and the posterior branch with the occipital artery on the back part of the head.

8. *The Internal Maxillary Artery**

Arises from the external carotid under the parotid gland, at a little distance below the neck of the condyloid process of the lower jaw, and extends to the bottom of the zygomatic fossa

* The general situation of this artery, and the distribution of several of its most important branches, cannot be understood without a knowledge of the bones through which they pass. The student of surgery will therefore derive benefit from a re-examination of these bones, and of the zygomatic fossa, &c. when he studies this artery. (See vol. i. page 114.) He ought to be well acquainted with this subject, if he should undertake the management of necrosis of the jaw bones; or of those fungous tumours, which sometimes originate in the antrum maxillare; as well as of several other complaints.

varying, its direction in its course. It is rather larger than the temporal.

A. It first sends off one or two small branches to *the ear*, and a twig which penetrates into the cavity of the tympanum by the glenoid fissure.

B. It also sends off a small artery called the *Lesser Meningeal*, which passes upwards, and after giving branches to the external pterygoid and the muscles of the palate, passes through the foramen ovale, and is spent upon the dura mater about the sella turcica.

C. It then sends off one of its largest branches, the *Great or middle Artery of the Dura Mater*, which passes in a straight direction to the foramen spinale, by which it enters into the cavity of the cranium.

This artery ramifies largely on the dura mater, and makes those arborescent impressions which are so visible in the parietal bone. It generally divides into two great branches: the anterior of which is the largest, passes over the anterior and inferior angle of the parietal bone: the posterior branch soon divides into many ramifications, which are extended laterally and posteriorly.

It furnishes the twig which passes to the ear by the hiatus of Fallopius, and anastomoses with the small branches of the stylo-mastoid artery.

It also supplies some other small vessels which pass to the cavity of the tympanum by small foramina near the junction of the squamous and petrous portions of the temporal bone.

D. The next branch sent off by the internal maxillary leaves it about an inch from its origin, and is called the *Inferior Maxillary*. It passes between the internal pterygoid muscle and the bone, and after giving small branches to the contiguous muscles, enters the canal in the lower jaw, in company with the nerve. This canal has a very free communication with the cellular structure of the jaw, and the artery in its progress along it sends branches to the respective teeth and the bone. At the anterior maxillary foramen this artery sends off a considerable branch which passes out and anastomoses with the vessels on the chin,

while another branch passes forward and supplies the canine and incisor teeth and the bone contiguous to them.

Sometimes the inferior maxillary artery divides into two branches before it has arrived at this foramen. In this case, one of the arteries passes out of the foramen, while the other continues to the symphysis.

E. Two branches pass off to the temporal muscle, which originate at a small distance from each other; one of them passes upwards on the tendon of the temporal muscle; the other arises near the tuberosity of the upper maxillary bone: they are called the *exterior deep, and the interior deep temporal artery.* They are both spent upon the temporal muscle; but the interior branch sends a small twig into the orbit of the eye.

F. There are some small branches which pass to the *Pterygoid Muscles* and to the *Masseter*, which arises either from the internal maxillary artery, or from the interior deep temporal. They are generally small, and often irregular.

G. An artery, particularly appropriated to the cheek, perforates the buccinator muscle from within outwards, and generally terminates on the buccinator, the zygomaticus major, and the muscles of the lips. This *Artery of the Cheek* is very irregular in its origin, sometimes arising from the internal maxillary, sometimes from the deep temporal, and sometimes from the suborbitary, or from the alveolar artery, to be immediately described.

H. The *Alveolar Artery* or the *Artery of the Upper Jaw*, arises generally from the internal maxillary, but sometimes from one of its branches. It winds round the tuberosity of the upper jaw, and sends branches to the buccinator muscle, to the bone and the gums, to the antrum Highmorianum, and some of the molar teeth: and also to the teeth generally, by means of a canal which is analogous to that of the lower jaw.

I. The *Infra orbitar Artery* arises from the internal maxillary in the zygomatic fossa, and soon enters the infra orbitary canal, through which it passes to the face, and emerges below the orbit of the eye, supplying the muscles in the vicinity, and anastomosing with the small ramifications of the two last described arteries, and also of the facial artery and the ophthalmic.

This artery in its course sends off small twigs to the periosteum, the adipose membrane, and the muscles in the inferior part of the orbit, and also to the great maxillary sinus or antrum Highmorianum, and to the canine and incisor teeth.

J. The *Palato-Maxillary* or *Superior Palatine Artery*, arises also in the zygomatic fossa, and, descending behind the upper maxillary bone, enters the posterior palatine canal. It generally forms two branches, the largest of which advances forward, supplying the palate and gums, and finally sends a twig through the foramen incisivum to the nose, while the posterior branch, which is much smaller, supplies the velum pendulum palati.

K. The *Pterygo-Palatine* or *Superior Pharyngeal*, is a small vessel, which sometimes arises from the artery next to be mentioned. It is spent upon the upper part of the pharynx, and a branch passes through the pterygo-palatine foramen, which is spent upon the arch of the palate and the contiguous parts.

L. The *Internal Maxillary* at length terminates in the *Spheno-Palatine*, or *Lateral Nasal Artery*, which passes through the spheno-palatine foramen to the back part of the nose. This artery sometimes separates into two branches before it enters the foramen; sometimes it enters singly, and divides into two branches soon after; one of them is spread upon the septum, and the other upon the external side of the nose; each of these branches ramifies very minutely upon the Schneiderian membrane and its processes in the different sinuses, and also in the ethmoidal cells.

Distribution of the Internal Carotid, the Vertebral and Internal Maxillary Arteries, as seen upon making a vertical Section of the Head, (*see Plate facing page* 233.)

A. The Upper Jaw Bone; part of it is torn away.
B. The Lower Jaw Bone; all the angle of the right side is taken away, to show the internal maxillary artery.
C. The Tongue.
D. The Antrum Highmorianum, torn open.
E. The Vertebræ of the Neck, cut to show the passage of the artery, encased in the bones.
F. F. The Skull-cap, sawn through exactly in the length of the longitudinal sinus.

Fig. 1.

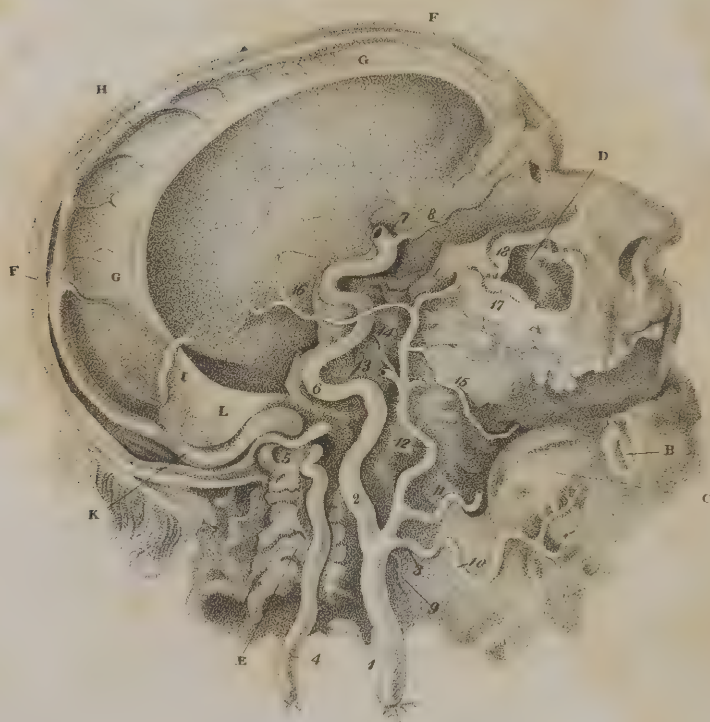
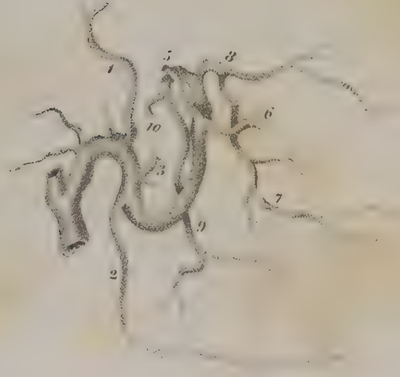


Fig. 2.



C. Bell del.

G. The Falx, which divides the hemispheres of the Brain.
H. The Longitudinal Sinus.
I. The Fourth Sinus, returning the blood from the lower sinus of the falx, and from the vena galeni.
K. Right Lateral Sinus.
L. The Tentorium, which covers the cerebellum, and supports the posterior lobes of the cerebrum.

Arteries.

1. The *Common Carotid Artery.*
2. The *Internal Carotid Artery.**
3. The *External Carotid Artery.*
4. The *Vertebral Artery ;* the processes of the vertebræ being cut away.
5. The last and violent turn of the Vertebral Artery, before entering the foramen magnum of the occipital bone.
6. The violent contortions of the Internal Carotid Artery, before entering the skull.
7. The point of the Internal Carotid Artery, where, after making its turns in its passage through the bone, it appears by the side of the sella turcica. See Plate at page 243.
8. The *Ophthalmic Artery*, derived from the carotid. It is this artery which is seen to inosculate with the Facial artery, in the preceding Plate, at page 228.
9. The *Thyroid Artery.*
10. The *Lingual Artery.*
11. The *Facial Artery* cut short; it is seen in the Plate, at page 228, Fig. 2, passing over the jaw.
12. The Continued Trunk of the External Carotid Artery; it is about to divide into the temporal and internal maxillary arteries. See the preceding Plate (11.)
13. The *Temporal Artery*, cut short.
14. The *Internal Maxillary Artery.*
15. That Branch of the Internal Maxillary Artery, which passes into the lower jaw.
16. The *Great* or *Middle Artery* of the *Dura Mater ;* a branch of the internal maxillary.†

* *Internal Carotid.* In Dr. Hooper's collection of preparations, there is a curious example of the ulceration of this artery. A man intending to destroy himself, attempted to swallow pins tied together; they stuck in the pharynx, and in time penetrated to this artery, which suddenly cut him off.

† It is this artery which rises through the spinous hole in the sphenoid bone, and then runs on the lower angle or spinous process of the parietal bone: here it

17. The Artery of the Upper Jaw.
18. The Infra Orbital Artery; it is seen to pass out upon the face.

Fig. 2, is a Plan of the Internal Maxillary Artery.

1. The *Meningeal Artery*, or great middle artery of the dura mater.*
2. The *Inferior Maxillary Artery.*†
3. Irregular Arteries: the *Pterygoid Arteries.*
5. The Deep *Internal Temporal Artery.*
6. The *Artery* of the *Cheek.*
7. The Artery of the Upper Jaw.
8. The *Infra Orbital Artery.*
9. The *Upper Palatine Artery.*
10. The Origin of the Upper Pharyngeal Artery.

The Internal Carotid Artery

Is sometimes called the *Artery of the Brain*, as it is almost entirely appropriated to that viscus.

From its origin to the commencement of its ramifications, the course of this blood-vessel is peculiarly tortuous. In consequence of which, the force of the blood in it is greatly diminished before it arrives at the brain.

An instance of this curvature occurs immediately after its separation from the external carotid, when it protrudes outwards so much as to be exterior to that vessel; after this it ascends to the carotid canal, and in its course is in contact, or very near the par vagum and intercostal nerves.

The carotid canal in the os petrosum is by no means straight; it forms a semicircular curve, forwards and inwards; and its upper portion, which is nearly horizontal, opens obliquely against

generally lies in a deep channel, and gives occasion to a kind of rule in surgery, to avoid applying the trephine at this part.

* This artery enters the skull by the foramen spinale of the sphenoid bone, and is the same that makes the deep furrow in the inside of the parietal bone. Mr. Walker, of Edinburgh, communicated a case where an arrow shot into the skull wounded this artery.

† *Lower Maxillary.* This artery enters at the posterior foramen of the lower jaw-bone, and courses within the bone, and appears on the chin, coming out through the mental foramen. In pulling the last molaris of the lower jaw, if the inner plate of the bone be broken off, and this artery torn up among the cells of the bone, the patient may die of bleeding.

the body of the sphenoidal bone, at a small distance from it. Therefore, after the artery has passed through the canal, it must turn upwards to get fairly into the cavity of the cranium; and, of course, its direction while in the canal, forms almost a right angle with its direction before it enters, and after it emerges from it.

In consequence of this curvature, much of the momentum of the blood must be impressed upon the cranium.

After the artery has arrived at the end of the carotid canal, and has turned upwards to get within the cavity of the cranium, it bends forwards, and passes nearly in a horizontal direction, through the cavernous sinus on the side of the sella turcica, to the anterior clinoid process; here it again forms a considerable curve, which is directly upwards, and then it perforates the dura mater.

These curvatures must also deprive the blood of the carotid of a portion of the momentum which it has retained after leaving the bone.

The object of these various flexures of the internal carotid appears to be analogous to that of the *Rete Mirabile* in certain quadrupeds, which is formed by the division of this artery into many small branches, that reunite again, without producing any other effect than the diminution of the momentum of the blood.

During its course from the place of bifurcation to its entrance into the carotid canal, the internal carotid artery very rarely sends off any branches. In the canal it gives off a *small twig* which enters the *cavity of the tympanum;* and sometimes a *second,* which unites with the *Pterygoid branch* of the internal maxillary.

As it goes by the sella turcica, it passes through the cavernous sinuses, and gives off two branches, which are called the *Posterior and Anterior Arteries of the Cavernous Sinus or Receptacle.*

The posterior branch goes to that part of the dura mater which is connected with the posterior clinoid process, and the cuneiform process of the occipital bone. It likewise gives branches to several of the nerves which are contiguous, and to the pituitary gland.

The anterior artery also gives branches to the contiguous nerves, to the dura mater, and the pituitary gland.

When the internal carotid turns upwards at the anterior clinoid process, it sends off the

Ophthalmic Artery,

Which passes under the optic nerve through the foramen opticum into the orbit of the eye, and is about a line and a half in diameter.

Although this artery enters the orbit under the optic nerve, it soon takes a position on the outside of it, but afterwards gradually proceeds to the inner side of the orbit, crossing *over* this nerve in an oblique direction, and finally passes out of the orbit near the internal angle. In this spiral course it sends off numerous branches, viz.

A. To those parts which are auxiliary to the eye.

B. To the ball of the eye.

C. To the cavity of the nose, through small foramina in the ethmoid bone, and

D. To the forehead and external side of the nose.

These branches generally go off in the following order:

1. The *Lachrymal Artery* arises soon after the ophthalmic arrives within the orbit, and passes above the abductor muscle to the lachrymal gland, where it terminates, sending off many small branches in its course.

2. The *Central Artery* of the retina also leaves the ophthalmic soon after its arrival in the orbit: it is a small vessel which penetrates into the centre of the optic nerve, and, passing with it into the eye, is spread upon the internal surface of the retina. Here it appears to terminate in the adult; but in the fœtus it is continued through the vitreous humour to the capsule of the crystalline lens.

3. While the ophthalmic is passing over the optic nerve the branches which enter the ball of the eye leave it. Their number varies, but they form three classes, viz. The *Long Ciliary*, the *Short Ciliary*, and the *Anterior Ciliary arteries*, (see description

of the eye,) the supra orbitary and muscular branches leave it also near the same place.

4. The *Supra Orbitary Branch* often gives off several muscular twigs: but it passes out of the orbit through the supra orbitar foramen, and generally divides into two branches, one of which is spent upon the periosteum, and the other upon the skin and muscles of the forehead.

5. There are sometimes *two muscular branches, a Superior and an Inferior.* The superior branch is often deficient: when it exists it supplies the levator palpebræ, the levator oculi, obliquus superior, &c.; but these parts are often supplied by the branches above mentioned. The supra orbitar so frequently gives off branches to the muscles, that it has been called the *Superior Muscular Branch.* The inferior muscular branch is more constant. It commonly supplies the rectus inferior, the abductor, and the inferior oblique muscles, and also the lachrymal sac, and the lower eyelid, &c.

When the artery is on the inside of the nerve it sends off the two branches to the cavity of the nose, viz. *The Ethmoidal Arteries;* and, also, branches to the eyelids.

6. The *Posterior Ethmoidal* branch is first. It passes between the levator and abductor muscles, and above the obliquus superior, and penetrates the cavity of the cranium by the posterior orbitary foramen: after giving some twigs to the dura mater, it passes to the posterior cells of the ethmoid by the foramina of the cribriform plate of that bone, and sends a small branch to the Schneiderian membrane on the back part of the septum of the nose.

7. The *Anterior Ethmoidal* artery arises from the ophthalmic nearly opposite to the anterior orbitary foramen, through which it passes: and after entering the cranium is distributed like the other through some of the foramina of the cribriform plate to the anterior cells of the ethmoid bone, and to the anterior part of the Schneiderian membrane on the septum of the nose, to which it sends a considerable branch.

In its course it sends twigs to the frontal sinuses, and to the dura mater and its falciform process.

8. The *arteries of the Palpebræ* are called *Superior* and *Inferior;* they leave the ophthalmic near the loop or pulley of the superior oblique muscle. The inferior comes off first; it sends branches to the ligaments of the tarsus, the caruncula lachrymalis, and the parts connected with the cartilage of the under eyelid, and unites with the lachrymal artery near the external canthus, forming an arch called the *Inferior Tarsal Arch.*

9. The *Superior Artery* supplies the superior part of the orbicularis muscle, the ligament and caruncula also: and it likewise unites with a twig of the lachrymal, and forms the superior tarsal arch.

Soon after sending off the palpebral branches, the *Ophthalmic Artery* arrives at the internal canthus, and then finally divides into two branches, the *nasal* and the *frontal.*

10. The *Nasal Branch* passes above the superior part of the lachrymal sac, and the ligament of the eyelid to the nose; after sending a twig to the frontal muscle and the lachrymal sac, it passes down the side of the nose and anastomoses with the facial artery.

11. The *Frontal Artery* is not so large as the nasal; it generally divides into three parts. A superciliary branch, which is principally spent upon the eyebrows; a superficial branch, which is spent upon the forehead; and a branch which is distributed to the pericranium.

The *Internal Carotid*, soon after parting with the ophthalmic, sends off, in a posterior direction, a branch to join one from the vertebral artery. From its destination, this vessel is called the *arteria communicans.*

After this it sends off another branch, which is so large that it may be considered as a continuation of the main trunk: this is called the *middle artery of the brain*, or the *Arteria Sylviana.* It runs outwards nearly in the direction of the fossa Sylvii, which separates the anterior from the middle lobes of the cerebrum. In its course it divides and subdivides into numerous branches, which are spread upon the *Pia Mater*, and finally enter the surface of the brain in a very minute state.

The internal carotid then terminates in a branch, which is

smaller than the last mentioned, and from its situation is called the *Anterior Artery of the Brain*, or *Arteria Callosa.* This vessel first inclines towards its fellow on the opposite side, and after approaching within half an inch of it, forms another curve, and runs forward to the anterior part of the brain, dividing itself gradually into two branches, which pass in several directions.

When these anterior arteries are nearest to each other, a small *transverse* branch, which passes at right angles, connects them together. This branch completes the anterior part of the *Circle of Willis.*

It crosses immediately before the sella turcica and pituitary gland, and sends off branches which pass to the third ventricle, to the fornix and septum lucidum, and also to the pia mater.

The *Anterior Arteries* of the brain also send off branches to the optic and olfactory nerves; to the opposite surfaces of the two hemispheres on each side of the falx, to their inferior surfaces, and to the corpus callosum.

They have likewise some branches which anastomose with those of the middle artery of the brain, and of the vertebral artery.

The Subclavian Arteries.

The *Right Subclavian* may be considered as the continuation of the arteria innominata. This last mentioned artery, after leaving the aorta, forms a curve or arch, which extends obliquely backwards and outwards, over the first rib to the axilla, crossing the trachea in its course. At the distance of an inch and a quarter, or an inch and a half from its origin, it sends off the right carotid, and then, assuming the name of *Right Subclavian*, continues in the above stated direction.

The chord of the curve of this artery, and the chord of the curve of the aorta, are not in the same direction, but form an angle with each other.

The position of the *Left Subclavian* is somewhat different from that of the right. Its origin is posterior, and, therefore, the direction of the chord of its curve is more immediately lateral. The curve or arch is also smaller. The situation of the two

subclavians as relative to the contiguous parts, is, therefore, somewhat different; but each of them proceeds between the anterior and the middle scaleni muscles, and when they have arrived at these muscles, their respective positions are very similar.

The anterior and middle scaleni muscles arise from the transverse processes of several of the cervical vertebræ, and are inserted into the first rib, one before the other, so as to leave a considerable space between them. The subclavian arteries pass through this space, but before they arrive at it, and when they are very near the above mentioned muscles, they send off several very important branches in various directions, viz. to the cavity of the cranium, to the parietes of the thorax, to the thyroid gland, and to the lower part of the neck.

They proceed near to the scaleni muscles before they send off any branches; and it is to be observed, that the subclavian veins which correspond with these arteries, are anterior to them, for they pass before the scaleni muscles, and not between them.

The Internal Mammary Artery

Goes downwards, from the lower and anterior part of the subclavian, along the inner side of the anterior scalenus muscle. It proceeds, exterior to the pleura, across the cartilages of the true ribs, and near their middle; and, continuing between the cartilages and the diaphragm, exterior to the peritoneum, terminates on the rectus abdominis muscle, in branches which anastomose with those of the epigastric artery. In this course, it gives branches to almost all the parts to which it is contiguous, viz. to the muscles and glands at the lower part of the neck; to the thymus gland; to the parts in the intercostal spaces; to the sternum; to the mediastinum and pericardium; to the diaphragm and to the muscles of the abdomen.

From some of its ramifications upon the parts between the ribs, small branches go off to the mamma, and thereby give a name to the artery. There is also a small vessel which is sent off by the mammary artery, or by one of its upper branches which accompanies the phrenic nerve to the diaphragm.

The Inferior Thyroid Artery

Arises from the upper side of the subclavian nearly opposite to the origin of the internal mammary. It passes upwards and inwards, between the carotid artery and the spine, to the thyroid gland: and then it anastomoses with the branches of the superior thyroid on the same side, and with those of its fellow on the opposite side.

This vessel sometimes sends off large branches to the muscles at the lower part of the neck.

The Vertebral Artery

Arises from the upper and posterior part of the subclavian. It goes upwards and backwards between the muscles which lie on the front of the spine, and passing under the transverse process of the sixth or seventh cervical vertebra, enters into the canal formed in the transverse processes of the vertebræ. In this course, as it proceeds from the third to the second cervical vertebra, it inclines outwards laterally, and, in its passage from the transverse process of the second to that of the first vertebra, it forms a considerable curve, the convexity of which has a lateral and external aspect. After passing the transverse process of the *Atlas*, it is turned suddenly backwards, in a groove, and finally passes through the great occipital foramen into the cavity of the cranium. It then proceeds upon the cuneiform process of the occipital bone, under the *Medulla Oblongata*, and joins its fellow so as to form an acute angle with it near the union of the medulla oblongata with the pons Varolii. From each of the vertebral arteries before their union, there generally goes off a small branch called the *Posterior Meningeal*, which is spent upon the posterior part of the dura mater.

The trunk formed by the union of the vertebral arteries is called

The Basilar Artery.

It extends forward near to the anterior part of the pons Varolii, where it bifurcates; but previously sends off several

branches on each side. The first pair go off in a lateral direction, soon after its commencement, near the back part of the pons Varolii, and are spent upon the medulla oblongata, the pons Varolii, and the other contiguous parts, and also upon the fourth ventricle and the *Plexus Choroides* of that cavity. They are called the *Posterior* or *Inferior Arteries of the Cerebellum.*

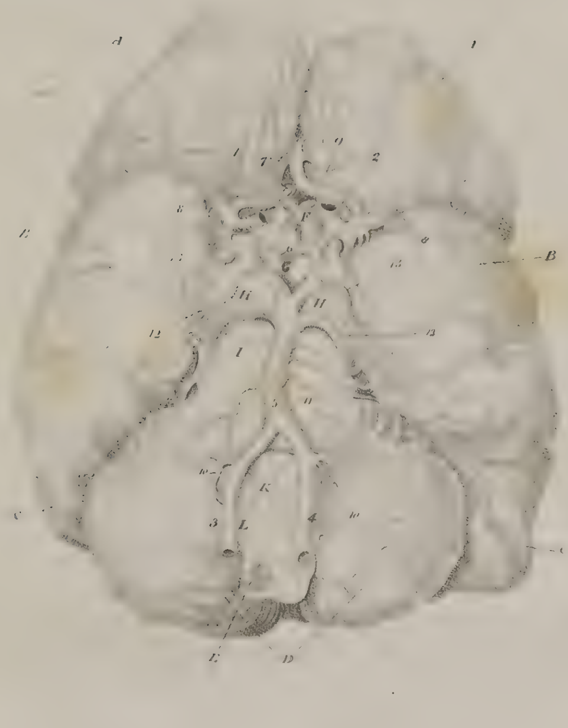
Two other lateral branches, which are called the *Superior Arteries of the Cerebellum,* go off from the *Basilar* artery, near its anterior extremity. These are principally spent upon the crura of the cerebellum and cerebrum: upon the cerebellum itself, and the contiguous parts.

Soon after sending off the last mentioned arteries, the *Basilar* artery divides into two branches, which also take a lateral direction, and are of considerable size. In their course outward, these branches are curved with their convexity forward. About ten or twelve lines from its commencement, each of them sends off a branch called the *Arteria Communicans,* which passes directly forward, and communicates with the internal carotid, thus forming the arrangement which is called the *Circle of Willis.** After sending off these arteries, they continue their lateral direction, and are distributed principally to the posterior parts of the cerebrum. These terminating branches of the *Basilar Artery,* are called the *Posterior Arteries of the Cerebrum.*

Arteries of the Brain, which are derived from the Internal Carotid and Vertebral, (*see Plate facing page* 243.)

A. A. The Anterior Lobes of the Cerebrum.
B. B. The Middle Lobes of the Cerebrum.
C. C The Posterior Lobes of the Cerebrum, which rest upon the tentorium.
D. The Right and Left Lobes of the Cerebellum.

* The arteria communicans is also considered as a branch of the *Internal Carotid.* The arrangement here alluded to is very remarkable. As the branches which pass off laterally from the single trunk of the *Basilar Artery* are united to the *Internal Carotids,* and the *Internal Carotids* are united to each other, there is an uninterrupted continuation of artery, which encloses a portion of space of a determined form; but this form resembles an oblong square more than a circle. By this connexion, blood will pass from any one of the four arteries of the brain to all the others.



del.

sculp.

E. The *Medulla Oblongata.*
F. The *Optic Nerves*, cut at their union.
G. The *Corpora Albicantia;* the *Infundibulum* is seen betwixt these and the optic nerves.
H. H. The *Crura Cerebri.*
I. The *Pons Varolii*, or Tuberculum Annulare.
K. The Eminences of the Medulla Oblongata, called *Corpora Pyramidalia.*
L. The *Corpora Olivaria.*

Arteries.

1. 2. The Right and Left Carotid Arteries, raised with the brain, and cut off as they rise at the point marked in the preceding Plate; that is, as they rise at the side of the sella turcica.
3. 4. The Right and Left *Vertebral Arteries.*
5. The Union of the Vertebral Arteries to form the *Basilar Artery.*
6. The Communicating Artery, or Anastomosis, betwixt the Basilar Artery and Carotid.
7. The Union of Communication betwixt the carotids of each side by the anterior arteries of the cerebrum; these anastomoses 6 and 7 form the *Circle of Willis.*

Divisions of the Internal Carotid Artery.

8. The *Middle Artery of the Brain* passing into the *Fissura Silvii.*
9. The *Anterior Artery* of the *Cerebrum.*

Branches of the Vertebral and Basilar Arteries.

10. The *Posterior Artery* of the *Cerebellum* from the Vertebral Arteries.
11. A very considerable branch of the Basilar Artery to the pons varolii and cerebellum, which, however, has no name.
12. The *Anterior Artery* of the *Cerebellum.*
13. The Posterior Artery of the Cerebrum.

The lesser branches of vessels seen in this Plate are mentioned in the text, but are not distinguished by any particular name.

The Superior Intercostal Artery

Arises from the upper part of the *Subclavian*, after the *Vertebral* and *Thyroid* arteries, and very near them. It descends by the side of the spine across the first and second ribs, near their heads, and exterior to the great *intercostal nerve.* It generally forms two branches, which are appropriated to the muscles, &c. in the first and second intercostal spaces, and sometimes a small

branch is continued to the third intercostal space. From each of these branches a small vessel proceeds backwards, and is spent upon the contiguous muscles, &c. on the back of the thorax. The *Intercostal Artery* also sends a branch upwards to the deep-seated parts of the neck.

In addition to the arteries above mentioned, there are several others of considerable size which originate either directly or indirectly from the *Subclavian*, and are spent upon the lower portion of the neck and the contiguous parts. These arteries are very different in different subjects, especially as to their origin. Two of them, which have been called the *Anterior* and *Posterior Cervicals*, are generally distributed to the muscles and other parts which lie on the lower portion of the neck anteriorly and posteriorly.

A third, which passes transversely on the lower part of the neck, is called the *Superior Scapular*.

In some cases, the two *Cervical Arteries* arise from the subclavian, after the mammary and the thyroid, in a common trunk, which soon divides. Very frequently they go off from the *Inferior Thyroid*. Sometimes one of them goes off from the *Inferior Thyroid* and the other from one of the branches of the *Subclavian*.*

The *Superior Scapular* most commonly arises with some other artery, and very often from the *Inferior Thyroid*. It runs transversely outwards within and above the clavicle, and passing through the notch in the upper costa of the scapula, divides into branches which are distributed to the parts on the dorsum of that bone.

The *Subclavian Artery*, in its progress from the aorta to the

* Haller paid great attention to the arterial system, and made many dissections, with a view to engravings of it, which he published with descriptions in folio fasciculi.

These fasciculi have been collected, and, with some other engravings, form a large volume, entitled ICONES ANATOMICÆ, which is truly valuable.

There are some very interesting observations on this work of Haller's, and also on these arteries, in a DESCRIPTION OF THE ARTERIES, by Dr. Barclay, of Edinburgh, which I have read with advantage, as well as a work on the muscles by the same author.

axilla, forms an arch or curve, over the fifth rib, as has been already observed. The anterior scalenus muscle is before it, and the great nerves of the upper extremity are above it. After passing between the scaleni, it descends upon the first and second rib into the axilla. The nerves which are above descend with it; at first they are necessarily exterior to it; but they form a plexus which the artery enters into, so as to be partly surrounded by them. This course of the artery is obliquely under the clavicle, and behind the pectoral muscle. In the axilla, the vessel and nerves which surround it are placed between the tendons of the pectoralis and the latissimus dorsi muscles. Here the artery takes the name of *Axillary*, and sends off several important branches.

The *principal* branches that go off from the *axillary artery* are distributed,

1st. Anteriorly, to the pectoral muscle, and the parts on the anterior surface of the thorax.

2d. Posteriorly to the muscles which are on the scapula and contiguous to it; and

3d. To the parts which are near the upper extremity of the os humeri.

Anterior Branches,

The arteries which go to the pectoral muscle, &c. are very various in different subjects, both as to their number, origin and size.

They have been called by different names, as *Thoracicæ Externæ, Mammariæ Externæ*, &c.

There are almost always three of them, and very often more: one of them, which is called by several authors the *Acromialis*, proceeds towards the end of the clavicle, and generally passes out at the interval between the deltoid and the pectoral muscle, sending various branches to the contiguous parts; the largest of its branches often passing in the direction of the interstice between those muscles.

Another of these arteries, which is called *Superior Thoracic*,

is generally very small: it often is a branch of the above mentioned *Acromialis.*

There is very often to be found here an artery called the *Inferior Thoracic*, or the *External Mammary*, which is of considerable length, although its diameter is not very great. This artery originates near the two last mentioned, and sometimes from the *Acromialis.* It often extends downwards as low as the sixth rib, and sends branches to the anterior part of the thorax, to the mamma, and other contiguous parts. Many of the small branches of this artery anastomose very freely with those of the internal mammary.

There are always one or more *small arterial branches* in the axilla, which ramify upon the glands and adipose matter always existing there. They often arise by one common trunk, which is called the *Thoracica Axillaris.*

Posterior Branch.

One large artery is commonly sent to the muscles on the scapula, which is called the *Scapular*, the *Common Scapular*, or the *Internal Scapular.* It commonly passes off from the axillary after the thoracic arteries, and supplies the muscles on both surfaces of the scapula. This large vessel passes downwards a short distance in the direction of the inferior costa of the scapula, and soon sends off a branch that winds round to the dorsum of the bone, to be distributed to the infra spinatus and the contiguous muscles, which is called the *Dorsalis Scapulæ.* The main trunk then inclines to the subscapularis muscle, and generally divides into two branches, which are distributed to the subscapularis, teres major, latissimus dorsi, &c.

Sometimes the *Scapular* artery divides into two branches before it sends off the dorsal. In this case the last mentioned artery goes off from one of those branches.

Branches near the Os Humeri.

The arteries which are near the body of the os humeri, at its upper end, are generally two in number, and denominated the *Anterior* and *Posterior Circumflex.* Sometimes they arise sepa-

rately, and sometimes in a common trunk from the *axillary* artery. Frequently, one of them arises from the scapular.

The *Anterior Circumflex* passes between the united heads of the biceps and coraco-brachialis muscles and the body of the os humeri, at a small distance below its head. It sends branches to the capsular ligament, the periosteum of the os humeri, the membranes of the groove for the long head of the biceps, the upper portions of the biceps and coraco-brachialis, and some contiguous muscles.

The *Posterior Circumflex* proceeds between the subscapularis and teres major muscles, and continues between the os humeri and the head of the triceps and the deltoides. It is distributed to the muscles and parts about the joint, especially to the deltoides.

These arteries surround the os humeri, and the small branches anastomose with each other. The *Posterior Circumflex* is much larger than the *Anterior*.

The great artery of the arm proceeds from the axilla to the elbow; and, during this course is generally denominated.

*The Humeral Artery.**

Its direction is influenced by the position of the os humeri. When the arm hangs down, with the palm of the hand presenting forward, this direction is somewhat spiral. The situation of the artery is on the inside of the biceps muscle, and between that muscle and the triceps extensor. It also continues very near and on the inside of the tendon of the biceps, and under the *Aponeurosis* which proceeds from that tendon. In consequence of the spiral or oblique course of the artery, its direction would be from the inside of the tendon of the biceps to the radial side of the fore-arm; but soon after it passes across the joint of the elbow, it divides into two branches: one which preserves, for some distance, the direction of the *Main Trunk*, is called the *Radial* artery: the other, which inclines obliquely downwards and towards the ulna, is the *Common Trunk* of the *Ulnar* and *Interosseal Arteries.*

* It is called the Brachial Artery by several writers.

During this course, the *Humeral* artery sends off several branches to the muscles and other parts on the os humeri. The largest of them is denominated the *Profunda Humeri* or *Spiralis*. This artery very often arises as high as the insertion of the latissimus dorsi, and passing between the heads of the triceps extensor muscle, proceeds downwards under that muscle in a spiral direction, towards the external or radial condyle. It sends several branches to the triceps and the contiguous muscles, and one considerable branch, which is generally called the *Profunda Minor*, to the parts contiguous to the internal condyle. The ramifications of these branches near the condyle frequently anastomose with small branches of the radial and ulnar arteries.*

A small branch frequently arises from the *Humeral* artery, at a short distance from the *Profunda Humeri*, which sends a ramification to the medullary foramen of the os humeri. This vessel is, therefore, denominated *Arteria Nutritia*.

There are very often several anastomoses between the branches of the *Humeral* artery which originate above the elbow, and certain branches of the *Radial* and *Ulnar* arteries which are called, from their direction, recurrents. Among these arteries there is generally one of considerable size, which proceeds across the elbow joint near the internal condyle. Sometimes this is the ulnar recurrent, which goes up to anastomose with the branches of the profunda; but more frequently it is a separate branch of the *Humeral* artery which goes off a little above the elbow, and passes across the articulation, near the internal condyle, to anastomose with the branches of the ulnar artery. This artery is denominated the *Anastomotica*.

There are often other branches sent off by the *Humeral* artery; but they are commonly small, and very irregular.

The two great ramifications of the *Humeral* artery on the fore-arm have very different directions. The *Radial* artery preserving the course of the main trunk while the *Common Trunk* of the *Ulnar* and *Interosseal* projects from it in a direction down-

* The profunda sometimes originates from the scapular, or one of the circumflex. The profunda minor sometimes has a distinct and separate origin, lower down than the other.

wards and towards the ulna, passing under the pronator teres, &c.

The Radial Artery,

Passing over the pronator teres muscle, proceeds between the supinator radii longus and the flexor carpi radialis, very near to the lower end of the radius, without changing its direction materially, being deep-seated above and superficial below; it then alters its course, and, passing under the tendons of the extensors of the thumb, to the back part of the radius, it continues between the metacarpal bones of the thumb, and of the index finger, when it divides into three branches.

In this course, it gives off but few branches. The first is the *Radical Recurrent*, which passes upwards and towards the external condyle, but frequently anastomoses with the ramifications of the profunda humeri.

The branches which it sends off between the origin of the recurrent and the lower end of the radius, are generally very small, and distributed to the parts immediately contiguous to the artery. Before it turns under the tendons of the extensors of the thumb, it sends a branch over the wrist towards the root of the thumb, from which proceeds a branch to anastomose with the volar branch of the ulnar; and another, not so large, which is frequently continued on the radial or external side of the thumb, very near to its extremity. While the radial artery is under the aforesaid tendons, it sends off small branches to the back of the wrist and back of the hand, and often to the back of the thumb. Those which are distributed to the wrist and back of the hand, generally anastomose with the small branches of the ulnar and interosseal arteries.

The three branches into which the *radial* artery divides between the metacarpal bones of the thumb and index are, 1st, *a branch to the external side of the index*; 2dly, *a branch to the thumb*, that sometimes divides into two, which pass up on the anterior or volar surface, and sometimes continue, without much diminution, on the internal side of the thumb, near to the end of the last phalanx; and, 3dly, a branch, called *Palmaris Profunda*,

which dips down into the palm of the hand, and proceeding in contact with the metacarpal bone, under the flexor tendons, &c. forms an arch which extends across the hand, and often terminates by anastomoses with another arch, soon to be described, which is formed by the ulnar artery.

This flexure, which is denominated *Arcus Profundus*, sends off branches of a very small size, which are distributed to the bones, ligaments, muscles, &c., contiguous to it.

The Common Trunk of the Ulnar and Interosseal Arteries

Passes under several of the muscles which originate from the internal condyle, and between the flexor sublimis and the flexor profundus. Before the *Ulnar Recurrent* goes off from this vessel, the *interosseal* artery often leaves it. This recurrent artery passes upwards between the muscles of the internal condyle, and distributes branches among them. It then passes up in the groove behind the internal condyle, and anastomoses with the branches of the *Anastomotica* or *Profunda Humeri.*

The ulnar and interosseal arteries separate from each other at the distance of fifteen or twenty lines from the origin of the *radial* artery, very near the commencement of the interosseal ligament.

The Interosseal Artery,

In a majority of cases, arises in a single branch from the common trunk of the ulnar and interosseal. When it does so, the single branch soon sends off the *Posterior Interosseal* artery, which perforates the interosseous ligament, and passes down on its posterior surface, while the main branch continues on the anterior surface of the ligament, and is denominated the *Anterior Interosseal Artery.* In some cases, the main branch proceeds on the anterior surface as low as the upper edge of the pronator quadratus muscle, before it sends off the posterior branch. Sometimes the anterior and posterior interosseals arise separately. In this case the posterior soon perforates the ligament.

The *Anterior Interosseal* passes down almost in contact with the ligament, and gives branches to the contiguous parts in its

course. It generally perforates the interosseous ligament near the wrist, and sends off many small branches to the back of the wrist and hand, which anastomose with the small branches of the radial and the posterior interosseal arteries.

The *Posterior Interosseal* soon gives off a recurrent or anastomosing branch, and then proceeds downwards towards the wrist, sending branches in its course to the extensor muscles and tendons.

This vessel sometimes divides into two branches.

The Ulnar Artery.

The *Ulnar* artery proceeds among the muscles obliquely downwards, and is not superficial until it has arrived within three or four inches of the carpus: it then continues towards the hand, sending off very small branches in its progress. It passes *over* the annular ligament at the wrist, and winds round the pisiform bone: here it is supported by a delicate ligament, which seems to lie upon it: from this it passes upon the palm of the hand, *under* the aponeurosis palmaris, and *over* the tendons of the flexors of the fingers. When thus situated, it forms, in perhaps a majority of subjects, an arch or bow, called *Arcus Sublimis*, which extends across the palm of the hand, from the ulnar towards the radial edge, and, after sending branches to the fingers, &c. from its convex side, terminates near the root of the thumb, by anastomoses with that important branch of the radial artery, which passes up on the inside of the thumb. The *Arcus Sublimis* almost always sends off small branches, to the integuments, &c. on the palm of the hand. It often sends off, near the root of the metacarpal bone of the little finger, a branch which passes between the flexor tendons and the metacarpal bones, and anastomoses with the *Arcus Profundus*. It then generally sends off a branch to the inner or ulnar side of the little finger; and afterwards three branches in succession, which pass from its convex side towards the angles formed by the fingers. These are called

The Digital Arteries.

When they have arrived near to the heads of the first pha-

langes of the fingers, each of these arteries divides into two branches, one of which passes along the side of one of the fingers to its extremity, and the other on the opposite side of the next finger: and in this way they pass on the sides of all the fingers, except the inside of the little finger, and the outside of the index.

These branches of the digital arteries are called *Digito-Radial* and *Digito-Ulnar* arteries, according to the sides of the fingers on which they are placed. They are situated on the angle, if it may be so termed, which is formed by the anterior and lateral surfaces of each finger. In their course from the basis to the extremity of the finger, they send off very small transverse branches, which anastomose with each other, especially near the other. Some transverse branches are observable on the posterior as well as the anterior surface. Near the extremity of each finger, beyond the insertion of the flexor tendon, the extremities of these arteries ramify minutely. Some of these small branches go to the skin, and others anastomose with their fellows of the opposite side. Some also go to the back of the fingers.*

Of the Arteries of the Arm, (*see Plate facing page* 253.)

A. The *Scapula.*
B. The *Pectoral Muscle* held up.
C. The *Deltoid Muscle.*
D. The *Biceps Muscle.*
E. The *Coraco-brachialis Muscle.*
F. The *Triceps extensor Muscle.*

* The distribution of the radial and ulnar arteries in the hand, is very different in different subjects.

Upon examining a large number of injected preparations in Philadelphia, it was found that, in a very small majority of them, the ulnar artery formed an arcus sublimis, whose branches extended as far as the ulnar side of the index, and sometimes beyond it.

That, in near a third of the preparations, the ulnar artery ramified without forming an arcus, and supplied only two of the digital branches, viz. the first two on the ulnar side. In such cases the radial artery generally made up the deficiency of the ulnar, but in a few instances the interosseal was extended on the palm of the hand, and supplied the radial side of the middle finger and the corresponding side of the index.

In a few instances also the ulnar artery was still more deficient, and the radial was proportionally extended.

Fig 1

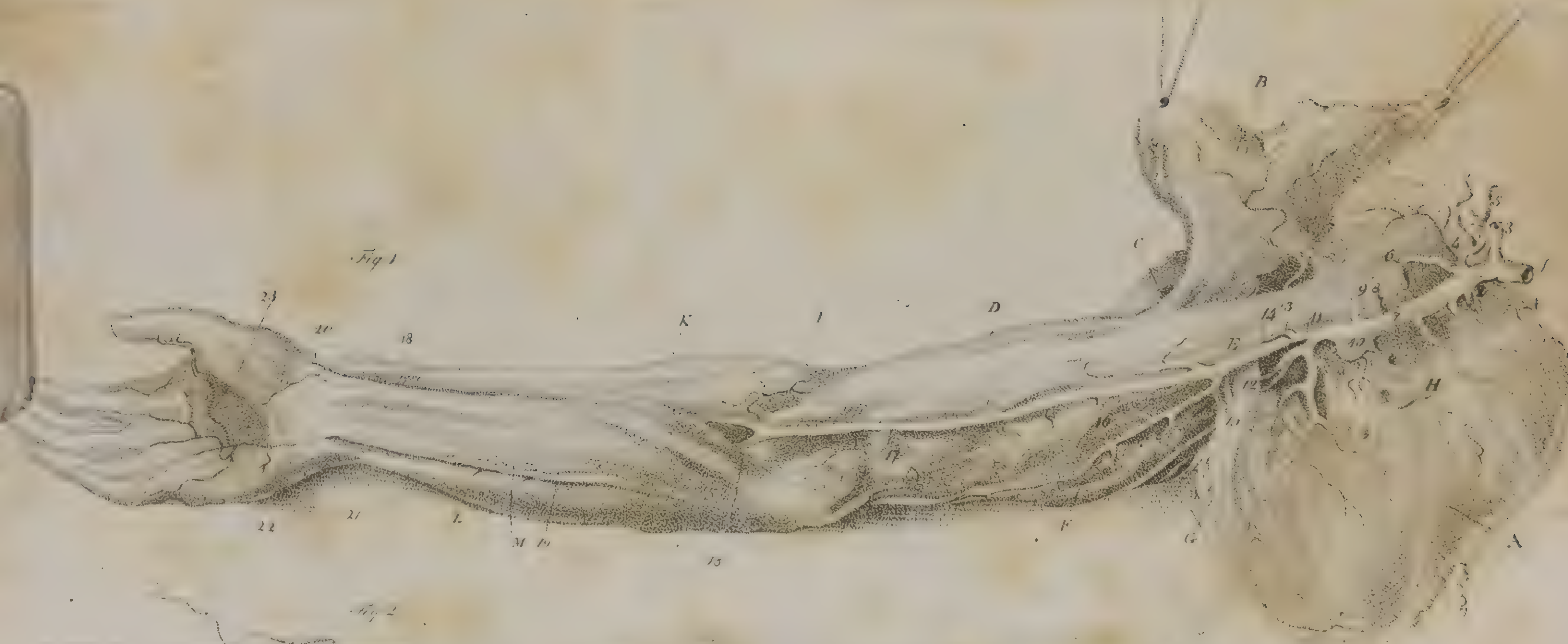
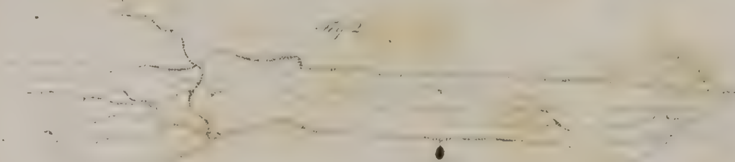


Fig 2



C. Bell del.

G. The *Teres Major.*
H. The *Tendon* of the *Lesser Pectoral Muscle.*
I. The *Supinator Longus.*
K. The *Extensor Carpi Radialis.*
L. The *Flexor Carpi Ulnaris.*
M. The *Palmaris Longus* and *Flexor Muscles* of the Fingers.

From the Aorta till the Artery passes over the first rib, it is called,

1. The *Subclavian Artery.* When this artery is injected, and tolerably full, it makes two pretty acute turns, in the form of an italic *S*, before it escapes under the clavicle. Its larger curve is just where it comes through the anterior and middle portions of the Scalenus muscle. It then descends directly across the first rib. It then comes out under the clavicle, three fingers' breadth from the inner extremity of the clavicle. Just at this point, viz. where it passes over the bulging of the rib, it may be compressed in the living body. Its branches are,
2. The *Internal Mammary Artery.**
3. The *Vertebral Artery.*
4. The *Thyroid Artery.*
   5. The Ascending Thyroid Artery, a branch of the last. The Transversalis Colli, or Cervicalis Posterior, is also generally a branch of the Thyroid, very irregular in its origin. Sometimes it comes from the Thyroid, and then receives the name of *Transversalis Humeri*; sometimes it comes from the place of the *Cervicalis Superficialis*, or even from the Subscapularis; sometimes from the Subclavian itself.

The *Deep* and *Superficial Cervical Arteries.*

6. The *Supra Scapular Artery.*

The Axilla.

7. The Trunk now assumes the name of *Axillary Artery.* Its branches are three or four to the chest; three to the scapula and shoulder.
8. The *Lesser Superior Intercostal Artery*, or *Superior Thoracic Artery.*
9. The *Greater* or *Longer Thoracic Artery*, or *External Mammary Artery.*
10. The *Thoracica Acromialis*, or *Humeraria.*

    The *Thoracica Axillaris* is not seen in this subject.
11. The *Subscapular Artery*; it is seen to divide upon the edge of the Scapula, into a deeper and a more superficial branch.

* Branches of the *Internal Mammary Artery.* 1. To the *Thymus.* 2. Accompanying the Phrenic Nerve. 3. To the Pericardium. 4. To the Mediastinum 5. Several branches to the Pectoral Muscle and Mamma. 6. To the Diaphragm. 7. To the Abdominal Muscles, inosculating with the Epigastric Artery. If a thrust be made with a small sword in any part (below the second rib) in a line parallel with the Sternum, and three-fourths of an inch from its edge, it will wound the Internal Mammary Artery.

12. The *Posterior Circumflex Artery* of the arm.
13. The *Anterior Circumflex Artery* of the arm.

In the Arm.

14. The Trunk now assumes the name of *Humeral Artery;* it gives off these branches:
15. The Superior, or *Greater Profunda.*
16. The *Lesser Profunda.*
17. The *Anastomoticus Major;* the lesser anastomosing branch comes off higher up, and follows the same direction round the inner condyle.

Arteries of the Fore-Arm.

Extremity of the *Humeral Artery.* The Artery divides three-fourths of an inch below the part of the *Median Basilic Vein*, where we generally bleed.

18. 18. The *Radial Artery.*

19. 19. The *Ulnar Artery.*

The Interosseous Artery, which divides into the *Inner* and *Outer Interosseous.*

The Recurrent Arteries from these last are, the

Recurrens Radialis Anterior.

Recurrens Ulnaris Anterior.

Recurrens Ulnaris Posterior.

Recurrens Interossea.

20. At this point the Radial Artery turns under the supinator tendon and extensor tendons of the thumb.

Superficial Artery of the Palm.

21. The *Ulnar Artery* passing over the wrist.

Dorsalis Ulnaris.

Arteria Palmaris Profunda Ulnaris.

22. The Great Palmar Arch, from which the Arteries of the fingers are seen to proceed.
23. This dotted line marks the seat of the Lesser Arch under the tendons.

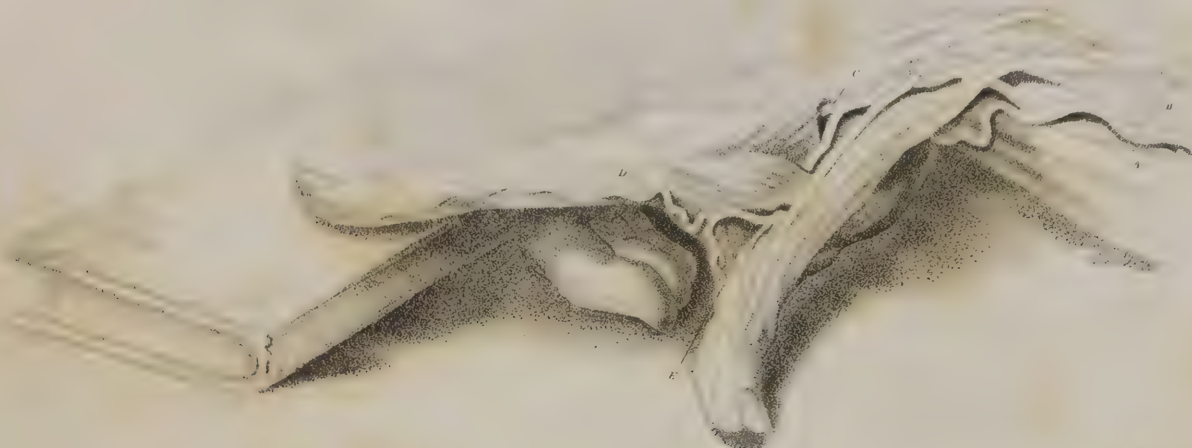
FIG. II.

From this sketch of the arteries we can follow in idea their continued course among the muscles.

Termination of the Radial Artery as seen on the Plate opposite, (from Bell.)

A. *Arteria Radialis.*
B. *Ramus Dorsalis.*
C. *Palmaris Profunda.*
D. *Ramus ad Indicem.*
E. *Ramus ad Pollicem.*

Additional Plate VI



Of the Branches which go off between the Arch and the great Bifurcation of the Aorta.

PART 1.

In the Cavity of the Thorax.

The aorta sends branches to the *Lungs*, to the œsophagus, and to the parietes of the thorax.

The Bronchial Arteries

Are the vessels which go from the aorta to the ramifications of the trachea, and the substance of the lungs. They are not large, and are very irregular as to number and origin.

In a majority of cases the right lung is supplied, in part, by a branch from the first aortic intercostal of that side; while the left lung receives two or three branches from the aorta directly. In some cases a large vessel arises from the aorta, which divides into two branches, one of which goes to each lung.

The *Bronchial* arteries frequently send small branches to the posterior mediastinum, the pericardium, &c.

Injections have shown, that there is a direct communication between these vessels and the branches of the pulmonary artery.

The Œsophageal Arteries

Are very small vessels, which generally arise from the aorta, but sometimes are branches of the bronchials or intercostals that are spent upon the œsophagus. They occur in succession. and sometimes are five or six in number. They also send twigs to the contiguous parts, and the lowermost often descend to the stomach.

The Inferior Intercostals

Are the arteries which proceed directly from the aorta to the parietes of the thorax. Their name is derived from their position between the ribs. They are ramified on the intercostal muscles and ribs, and on the pleura and some of the contiguous parts.

They are called *Inferior* or *Aortic Intercostals*, to distinguish them from the superior intercostals, which are derived from the subclavian artery. Their number varies from ten to eight, according as the superior intercostals are more or less numerous.

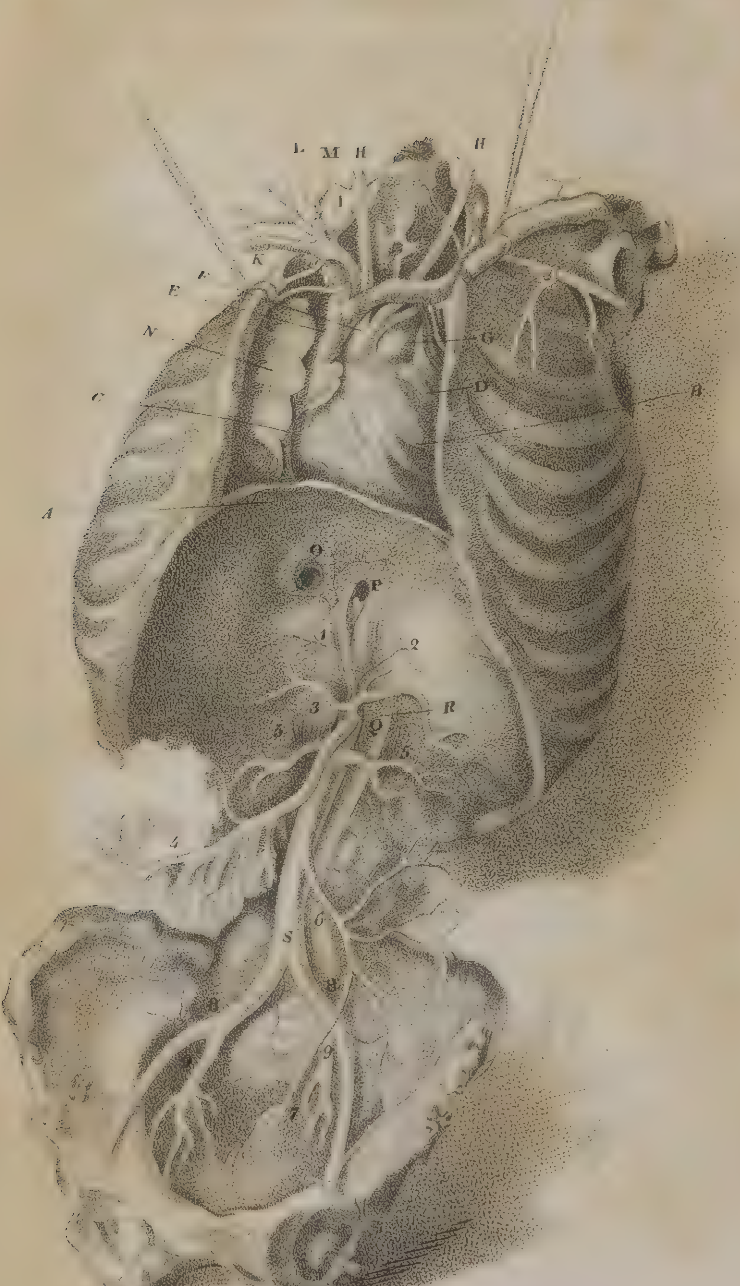
They originate in pairs on the posterior surface of the aorta. The uppermost of them pass obliquely upwards, and the lowermost nearly in a horizontal direction, to the lower edges of those ribs to which they are appropriated. They meet the rib near its tubercle, or place of junction with the transverse process of the vertebra, and then proceed forward, between the internal and external intercostal muscles, in a superficial but large groove, which is generally to be found on the interior margin of the lower surface of the rib.* There is necessarily a difference in the length of the right and left intercostals, owing to the position of the aorta, which is rather on the left of the spine. In consequence of this circumstance, the œsophagus is anterior to, and also in contact with those of the right side.

They generally send off an important branch, called the *Dorsal*, which arises near their origin, and, passing backwards, sends ramifications to the muscles of the back. From this dorsal branch also proceeds a ramification, which enters the spinal cavity, and is spent upon its membrane and upon the medulla spinalis.

After the *Intercostals* in their progress forward, have passed beyond the middle of the ribs, they send off a branch, which generally proceeds very near to the upper side of the lower rib. The main trunk generally leaves the lower edge of the rib when it has arrived within one-third of the length of the bone from its anterior extremity. It then generally divides into several branches, some of which are spent upon the pleura, and others on the intercostal and the contiguous muscles.

According to the situation of the different intercostals, some of their ramifications, communicate with those of the internal and external mammaries, of the phrenic, the lumbar, or the epigastric arteries.

* See Vol. i, page 136.



C. Bell del.

D. Edwin sculp.

PART 2.

In the Cavity of the Abdomen.

The *Aorta* passes into the cavity of the abdomen between the crura of the diaphragm, as has been already mentioned. In its course from the crura to its great bifurcation, it sends off one pair of small arteries, called *Phrenic*, to the diaphragm. Three single arteries, the *Cœliac*, the *Superior*, and the *Inferior* mesenteric, to the viscera of the abdomen. A pair of large arteries, the *Emulgents*, to the kidneys, with several that are very small to their appendages; as the *Spermatics*, *Capsular*, the *Ureteric*, and the *Adipose*. In addition to these, there is one pair of small arteries that go to the testicles, or to the ovaria and the uterus, and four or five pair, called *Lumbar Arteries*, that go off laterally, like the intercostals, to the parietes of the abdomen, and to the muscles, &c. on the back, which are contiguous to them.

Representation of the Diaphragm, the Situation of the Heart, the Blood-vessels of the Breast, and Abdominal Aorta. (*See Plate facing page* 257.)

A. The *Diaphragm*, dividing the thorax from the abdomen.

B. The Heart, lying upon the diaphragm, and with the apex obliquely to the left side.

C. The *Right Auricle.*

D. The *Left Auricle ;* that which receives the blood from the lungs.

E. The *Superior Vena Cava*, returning the blood from the arms and head to the right auricle.

F. The *Arch* of the *Aorta.*

G. The *Pulmonary Artery.*

H. H. The *Right* and *Left Carotid Artery.*

I. The *Subclavian Artery.*

K. The *Internal Mammary Artery.*

L. The *Thyroid Artery*, to the shoulder, the neck, and the thyroid gland.

M. The *Vertebral Artery.*

N. The *Lungs* of the right side.

O. The Perforation of the Diaphragm, for the transmission of the inferior cava.

P. The Hole by which the Œsophagus passes into the abdomen.

Q. The Lesser Muscle of the Diaphragm. See the text, p. 312, Vol. i.

R. S. The whole length of the Abdominal Aorta. It is seen embraced by the diaphragm at R., and immediately giving off the phrenic and cœliac arteries.
1. The *Right Phrenic Artery.*
2. The *Left Phrenic Artery.*
3. The Root of the *Cœliac Artery.*
4. 4. The *Upper Mesenteric Artery.*
5. 5. The *Emulgent Arteries.*
6. The *Lower Mesenteric Artery.*
7. The *Hæmorrhoidal Artery,* a branch of the last.
8. 8. The *Common Iliac Arteries.*
9. The *Internal Iliac.* It is seen to give off the gluteal, the ischiatic, and the obturator artery.

The Phrenic Arteries

Are ramified on the concave surface of the diaphragm, and are almost always two in number; they are denominated *right* and *left* from their position. They commonly originate separately from the aorta, but sometimes they arise in a common trunk which soon divides. In some instances they are derived from the cœliac. In a few cases, the aorta furnishes one, and the cœliac the other. Each of the phrenic arteries commonly crosses the crus of the diaphragm on its respective side, and proceeding laterally, in a circular direction, often ramifies so as to form an internal and external branch. Each of them generally sends branches to the cardia or œsophagus, to the glandulæ renales, and other contiguous parts.

The Cœliac Artery,

Is the first great branch given off by the aorta in the abdomen, and is distributed almost entirely to the stomach, the liver and the spleen. It projects from the anterior part of the aorta so as to form a right angle with it, and is of course nearly horizontal, when the body is erect.

The main trunk of this great artery is so remarkably short, that it has been compared to the stump of a tree; for, at the distance of half an inch from its origin, it generally divides into three branches, which pass to the stomach, the liver, and the spleen, and are, therefore, denominated the *Gastric* or *Coronary,* the HEPATIC and the SPLENIC arteries.

The first mentioned branch may be called

The Superior Coronary or Gastric Artery,

To distinguish it from other branches, soon to be described. It is commonly in the centre of the three great ramifications of the cœliac, and is also the smallest of them. It proceeds from its origin to the upper orifice of the stomach or cardia, and continues thence along the lesser curvature of that viscus until it approaches near to the pylorus. In this course it sends branches to the œsophagus, which frequently inosculate with the œsophageal arteries. It also furnishes branches to the cardia, which partially surround it; and, on this account, the artery has been called *Coronary*. Some of these last mentioned branches are often continued on the great extremity of the stomach, and anastomose with those ramifications of the splenic artery, called *Vasa Brevia.*

It continues on the lesser curvature between the lamina of the small omentum, and sends off successively branches which pass between the peritoneal and muscular coats, and are distributed to the anterior and posterior surfaces of the stomach, communicating with the branches of the inferior gastric arteries, soon to be described.*

The Hepatic Artery

Proceeds from the great ramification of the cœliac to the transverse fissure of the liver called the *Portæ*, in which it generally divides into two branches. In this course it very frequently sends off an artery to the pylorus, which ramifies about the small extremity of the stomach, and often inosculates with some of the branches of the superior coronary. This branch is called the *Pylorica*, and sometimes it arises from the artery next to be mentioned.

The Gastrica Inferior Dextra,

Which also generally originates from the main trunk of the

* This artery sometimes sends a branch to the liver. When this is the case, it is always very large.

hepatic, but sometimes from one of its branches. It is an artery of considerable size, which proceeds along the great curvature of the stomach, from the pylorus towards the great extremity between the lamina of the anterior portion of the omentum, and distributes its ramifications to both sides of the stomach, and also to the *Omentum.* In its progress from the hepatic artery to the stomach, it sends off branches to the *Duodenum* and to the *right end* of the *Pancreas.*

The two great branches into which the HEPATIC artery divides, are denominated *right* and *left,* from the lobes of the viscus to which they are respectively appropriated. The right branch is the largest. Before it penetrates the substance of the liver, it sends off a branch to the gall-bladder, called the *Cystic Artery.*

The branches of the hepatic artery ramify very minutely in the liver, as has been stated in the account of that organ.

The last great branch of the cœliac is

The Splenic Artery,

Which is generally supposed to be larger than the hepatic in adults, although it is less in children. It proceeds in a transverse direction from its origin to the spleen: its course is not straight, but meandering or serpentine. It is situated behind and above the pancreas, and passes along the groove in the upper edge of that viscus. In its progress, it sends off many small branches, and one that is of considerable size, to the *Pancreas.* It also sends one branch to the left extremity of the stomach, which arises commonly from the main trunk, but sometimes from the ramifications, which are soon to be mentioned. This branch, which is called

The Gastrica Inferior Sinistra,

Is sometimes, but not often very large: its course is from left to right. It is situated between the lamina of the anterior portion of the omentum. It sends some small branches to the omentum, and others which are larger and more numerous, to both sides of the stomach. Some of these last mentioned anas-

tomose with the ramifications of the gastrica dextra which come from the hepatic.

When the *Splenic* artery approaches near to the spleen, it divides into four, five, or six branches, each of which penetrates into that viscus by a distinct foramen, and then ramifies in the manner described in the account of the structure of the spleen.*

Either from the splenic artery, or from these ramifications, four or five branches pass to the large extremity of the stomach and ramify there, communicating with the vessels already described. These arteries have received great attention from physiologists, and are denominated *Vasa Brevia.*

The Superior Mesenteric,

Which is the second great branch given off in the abdomen by the aorta, is not very different in size from the cœliac, and originates about half an inch below it. It is distributed to the small intestines; so that portion of the great intestine which is situated on the *right side* of the abdomen; and to the *arch* of the colon. From its origin it proceeds downwards, under the pancreas, and over the lower portion of the duodenum, to the commencement of the mesentery. When it has arrived between the lamina of that membrane, it descends in a direction which corresponds with that of the root of the mesentery,† and forms a gentle curve, with its convexity directed towards the intestines. It necessarily diminishes as it descends, and generally terminates by anastomosing with one of its own branches. This great artery sends off some very small ramifications to the pancreas and the duodenum, while it is in their vicinity. It also sends two or three branches to the transverse part of the colon, to the right portion of the colon, to the beginning of the great intestine, and the contiguous portion of the ileon. These branches are commonly termed the *Colica Media*, *Colica Dextra*, and *Ileo Colica.* From the convex side of the curve, the *superior mesenteric* sends off the important branches which pass between the lamina of the

* It frequently happens that the splenic artery divides only into two or three branches, and they subdivide so as to form five or six, which penetrate the spleen.

† Vol. ii. p. 50.

mesentery, and supply the *Small Intestines.* These branches are numerous, and many of their ramifications anastomose with each other, so as to form arches. From these arches go off other branches, which anastomose again with some of similar origin; and this process is repeated successively several times, so that a net-work of blood-vessels seems to be formed on the mesentery. From the mesentery the small ramifications are continued, in great numbers, to the intestines. Some of them anastomose with each other on the coats of the intestine; but an immense number of minute arteries are continued to the villous coat, so that, when they are successfully injected, the surface of that coat appears uniformly coloured by the injection.*

The Inferior Mesenteric Artery

Does not go off from the aorta next in order after the superior mesenteric, but succeeds it immediately on the intestines, and continues the arterial ramifications to the *left portion of the colon,* to which the branches of the superior me enteric do not extend.

This artery arises between the origin of the emulgents and the great bifurcation of the aorta, and proceeds downwards, inclining to the left, but keeping near to the aorta. There are generally three branches distributed to the left portion of the colon, which arise from this artery, either separately, or by a common trunk which soon divides. It frequently happens, that one of these arteries arises separately, and two by a common trunk. These are called the *Left Colic* arteries; and are also sometimes denominated, from their position, *Superior*, *Middle*, and *Inferior.* The *Superior* generally anastomoses with that branch of the superior mesenteric, which is called *Colica Media,* and forms a remarkable arch, called the *Great Mesocolic Arch.* The ramifications of the other branches frequently anastomose with each other, and are finally spent upon the left portion of the colon.

The main trunk, diminished by sending off these branches,

* See the account of the termination of these arteries, at page 44 of this volume.

but still of considerable size, runs downwards on the posterior part of the intestine rectum, between that intestine and the sacrum, where it often divides into two branches, which continue near to the termination of the rectum. From them proceed many ramifications that are spent upon the rectum. Some of these ramifications anastomose with each other, and others with the ramifications of the hæmorrhoidal artery, soon to be mentioned.

The Emulgent or Renal Arteries

Are the large vessels which pass from the aorta to the kidneys. They arise between the superior and inferior mesenterics, one on each side; and proceed in a direction which is nearly rectangular to the aorta. The right emulgent artery is necessarily longer than the left, and it generally passes behind the vena cava. When they approach near the concave edges of the kidneys, each emulgent commonly divides into three or four branches, which pass into the fissure of that organ, and ramify in the manner described in the account of it. Sometimes two arteries proceed from the aorta to the kidney; but this is not a frequent occurrence.

The Capsular Arteries

Are the small vessels which pass to the glandulæ renales. There are almost always several of them appropriated to each gland. They often arise on each side from the cœliac artery, the aorta, and the emulgent.

The Adipose Arteries

Supply the adipose substance surrounding the kidneys. There are several of them on each side, and, like the last mentioned arteries, they are very small, and arise from several sources as well as the aorta.

The testicles and ovaria are supplied by the

Spermatic Arteries,

Which are very remarkable for their great length and small diameter. In a majority of cases, these vessels arise from the

anterior surface of the aorta, a little below the emulgents: but it often happens that the left spermatic arises from the emulgent on that side. They also sometimes arise from other neighbouring arteries. It has been observed, when they arise from the aorta, that the origin of one of them is generally higher than that of the other.

They pass downwards, so as to form an acute angle with the aorta, and proceed behind the peritoneum, and before the psoas muscle and ureter. While this artery is in contact with the psoas muscle, it meets with the ramifications of the *spermatic vein*, and, in its progress to the abdominal ring, also joins the *spermatic cord.* In this course it sends off some very small twigs to the contiguous parts, and others that anastomose with similar ramifications from the mesenteric, epigastric, &c. Before it arrives at the testicle, it divides into several branches, two of which generally go to the epididymis, and the others penetrate the upper and back part of the tunica albuginea.

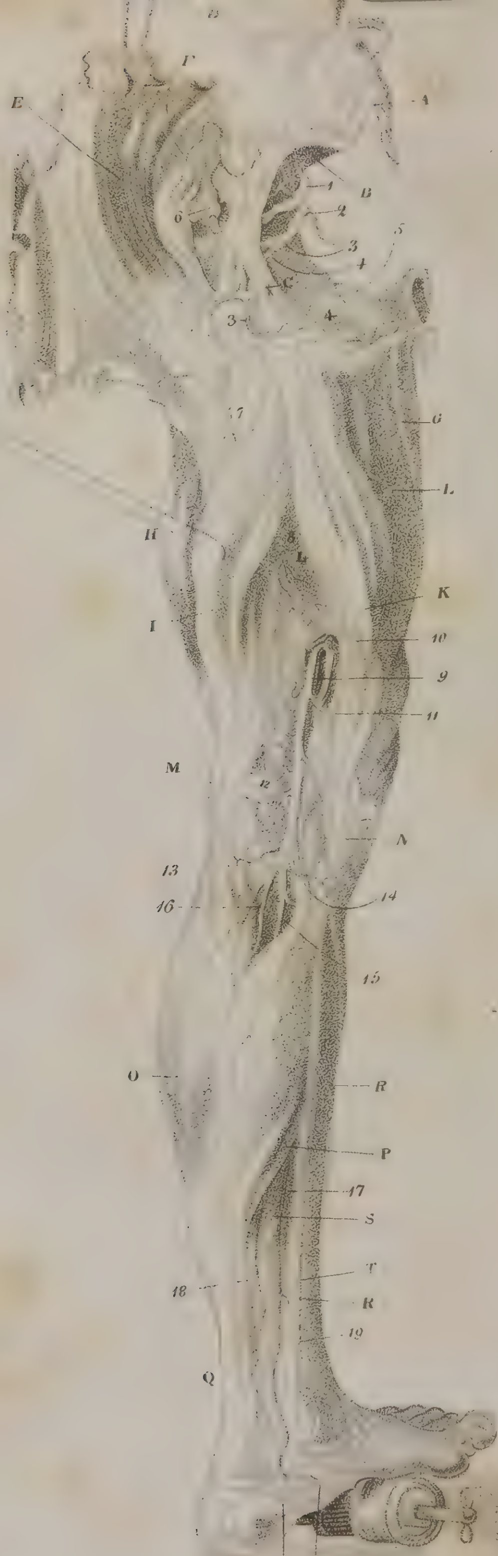
The Spermatic Arteries in the Female,

Instead of passing to the abdominal ring, proceed between the lamina of the broad ligaments, and send branches to the ovaria, which, in some cases, may be traced to the vesicles. They also send branches to the Fallopian tubes and uterus, and to the round ligaments. Those which are on the opposite sides of the uterus, anastomose with each other, and with the branches of the hypogastric arteries.

The lumbar regions are supplied with arteries which originate, like the intercostals, from the posterior part of the aorta between the thorax and pelvis. There are four or five of these vessels on each side, and they are denominated

The Lumbar Arteries.

They pass between the spine and the psoas muscle, and send branches to the spinal cavity, to the muscles of the lumbar regions, and the abdominal muscles. They anastomose with the internal mammary, the epigastric, the circumflex of the ilium, &c.



C. Bell del.

D. Edwin sculp.

A small artery passes off singly from the posterior part of the aorta at its bifurcation, which is called

The Middle Sacral Artery.

It proceeds down the middle of the sacrum to the os coccygis, and sends off lateral branches, which are spent upon the contiguous parts, and inosculate with the arteriæ sacræ laterales.

Of the Arteries which originate at and below the Great Bifurcation of the Aorta.

The Primitive Iliacs

Form an acute angle with each other. They proceed downwards behind the peritoneum, very near the margin of the pelvis, without sending off any branch of importance. At the junction of the sacrum with the ossa ilia, they divide into two great branches: the *Internal Iliac*, or *Hypogastric*, which descends into the pelvis; and the *External Iliac*, which passes under the crural arch to the lower extremity.

Arteries of the Pelvis and Ham, (from Bell.) *See plate facing page* 265.

A. The body of the last Lumbar Vertebra sawn through.
B. The *Sacrum.*
C. *Ischiatic Ligaments.*
D. The *Lumbar Muscles.*
E. The *Great Gluteus Muscle.*
F. The *Lesser Gluteus Muscle.*
G. The *Gracilis Muscle.*
H. The *Vastus Externus Muscle.*
I. The Outer Hamstring Muscle; i. e. the Biceps.
K. The Inner Hamstring Muscles, i. e. the *Semi-tendinosus* and *Semi-membranosus.*
L. L. The *Triceps.*
M. The *Outer Condyle* of the thigh bone.
N. The *Inner Condyle.*
O. The Belly of the *Gastrocnemius Muscle.*
P. The *Soleus Muscle.*
Q. The Achilles Tendon.
R. The Tibia.

S. The Flexor Longus Pollicis.
T. The Flexor Digitorum Communis.
1. The *Internal Iliac Artery;* giving off,
2. *Hypogastric Artery.*
3. 3. Ischiatic Artery.
4. 4. The *Pudic Artery.*
5. The *Obturator Artery.*
6. 6. The *Gluteal Artery.*
7. A branch from the *Internal Circumflex Artery.*
8. Branches of the Perforating Arteries of the *Profunda.*
9. The Popliteal Artery after it has pierced the Triceps Muscle.
10. Those branches sent off from the main artery as it is passing the tendon; they are called the perforating branches of the Popliteal Artery.
11. The *Upper* and *Internal Articular Artery.*
12. The *Upper External Articular Artery.*
13. The *Lower External Articular Artery.*
14. The *Lower Internal Articular Artery.*
15. The *Posterior Tibial Artery;* the Anterior Tibial Artery (see plate, page 265,) is a branch sent off from this.
16. The *Peroneal Artery,* or Fibular Artery.
17. The *Posterior Tibial Artery* appears here again from under the *Soleus Muscle.*
18. The *Fibular Artery;* it is seen to form large inosculations with the Tibial Artery.
19. A remarkable inosculation betwixt the *Tibial* and *Fibular Arteries.*
20. The *External Plantar Artery.*
21. The *Internal Plantar Artery.*

The Internal Iliac, or Hypogastric,

Is distributed, in part, to the viscera of the pelvis and the organs of generation, and also to the large muscles exterior to the pelvis: it is, therefore, very large, although not quite equal to the *External Iliac.*

It has already been mentioned, that in the fœtal state, this vessel appears to continue in a curved direction from its origin to the lower part of the side of the bladder, and from thence to the umbilicus, under the denomination of the *Umbilical Artery.* From the convex side of this curve the different branches of the internal iliac go off. In the fœtal state they are very small, in proportion to the umbilical artery; but as the artery becomes ligamentous, these branches increase in size.

In the adult, the arrangement of these vessels is very different. The *Internal Iliac* generally divides into two great branches; the *Gluteal*, which passes through the sacro-sciatic notch, and ramifies on the exterior and upper part of the os ilium: and the *Ischiatic*, which passes downwards on the outside of the tuberosity of the ischium.

The first of these large ramifications passes out of the pelvis above the pyriform muscle, and the last of them below it. Several smaller arteries arise from these branches near their origin, or from the main trunk of the internal iliac, which are distributed to the different parts of the pelvis; and one important branch of the ischiatic, called the *Pudic*, proceeds downwards on the inside of the tuberosity of the ischium.

The first of the smaller branches which the external iliac commonly sends off, is called the

Ileo Lumbalis.

It sometimes arises from the gluteal artery, and sometimes from the main trunk of the internal iliac. It passes outwards under the psoas muscle, and suddenly divides into two branches. One of them proceeds upwards, and is distributed in the lumbar region, while the other ramifies on the iliacus internus muscle, and is spent on the contiguous parts.

There are, also, two or three small arteries called

Arteria Sacræ Laterales,

Which sometimes arise singly, and sometimes in common, from the great trunk. They also occasionally originate from the gluteal artery. These vessels enter the anterior foramina of the os sacrum, to be distributed on the cauda equina and the membranes which invest it. Some of their ramifications anastomose with branches of the sacra media and other contiguous arteries.

On the anterior side of the internal iliac, near the origin of the above mentioned vessels, a ligament, which was originally the *umbilical* artery, goes off to the side of the bladder, and continues from thence to the umbilicus. Sometimes it continues

pervious for a short distance, and then small branches pass from it to the bladder.

In the female it also sends small branches to the uterus and vagina.

In addition to these *Vesical Arteries* derived from the umbilicals, there are other branches distributed to the bladder, which arise very differently, in different subjects, from branches which are soon to be described, as the hemorrhoidal, pudic, &c.

From the anterior side of the internal iliac, or from one of its great branches, an artery often arises which passes out of the pelvis through the aperture in the margin of the ligamentous membrane which closes the foramen thyroideum of the os innominatum; this is called the

Obturator Artery.

This vessel, while it is in the pelvis, often sends small branches to the bladder and its appendages, and to the obturator internus muscle. After it passes out of the pelvis, it frequently divides into branches; some of which are spent on the obturator externus, and the contiguous muscles, and others go to the hip joint. The origin of this artery is variable. Most commonly it arises from the internal iliac, but often from the ischiatic, and sometimes from the gluteal. In some instances, it originates in a way that is particularly interesting, when the operation for crural hernia is to be performed, viz. from the *epigastric artery*, soon to be described: for in this case the obturator artery sometimes nearly surrounds the neck of the hernial sac.*

A small artery passes from the internal iliac or one of its branches, to the rectum, which is called the

Middle Hæmorrhoidal,

From its situation between the branches which are sent to that intestine from the inferior mesenteric, and those which go to it

* See Astley Cooper's great work on Hernia, vol. i.
There is reason to believe that this position of the artery occurs more frequently than has been supposed.

from the pudic. This artery is spent upon that part of the rectum which is above and in contact with the sphincter. It sends branches to the prostate and vesiculæ seminales, in males, and to the vagina and bladder in females.

In females there is a peculiar artery,

The Uterine,

Which originates either from the internal iliac, near the origin of the ischiatic, or from one of its branches. It passes between the lamina of the broad ligaments to the cervix uteri, and penetrates the texture of that organ. The size of this vessel varies with the varying size of the uterus.

The Gluteal or Posterior Iliac Artery,

One of the two great branches of the internal iliac, proceeds exteriorly through the sciatic notch *above* the pyriform muscle, very near the edge of the bone. On the outside of the ilium it generally divides into two branches, one of which ramifies between the gluteus medius and minimus, and the other between the medius and maximus. It is principally spent upon these muscles, and sends branches to the contiguous parts.

The Ischiatic Artery.

The other great branch of the internal iliac, passes through the sciatic notch *below* the pyriform muscle, and proceeds downwards, between the great trochanter of the os femoris and the tuberosity of the ischium, under the gluteus maximus muscle. Soon after its origin, it *commonly* sends off a considerable branch, the *Arteria Pudica,* which also passes downwards: it then continues its course as above mentioned, and its principal branches are distributed to the gluteus maximus and the muscles of the upper and back part of the thigh, while its smaller branches go to the os sacrum and coccyx, and the contiguous small muscles.

The Pudica Interna,

As has been just mentioned, is often a branch of the ischiatic artery, but sometimes originates immediately from the internal

iliac. It proceeds downwards and inwards, diverging from the ischiatic, and passing between the two sacro-sciatic ligaments to the interior side of the tuberosity of the ischium, whence it continues on the inside of the crus of the os ischium and pubis until it approaches the symphysis, when it generally divides into three branches, which are spent upon the organs of generation, from which circumstance the name of this artery is derived.

One or more branches from it also pass to the lower part of the rectum and sphincter ani, and are called the *Lower Hæmorrhoidal Arteries.*

In its course, it sends off many small branches to the contiguous parts; one of which, called the *Perineal*, leaves it near the transversus perinei, and passes between that muscle and the skin, and between the bulb of the urethra and the crus of the penis, to the scrotum.

When the *Pudic* has arrived near the bulb of the urethra, it sends a branch into it, which is continued into the corpus spongiosum urethræ, and ramifies there minutely.

At the symphysis of the pubis it sends off a second branch, which passes to the back of each crus, and, proceeding along it, parallel to its fellow, terminates in the glans penis: in this course it sends branches to the elastic coat, to the integuments, and to the prepuce. This vessel is called the *Arteria Dorsalis.*

The main trunk of the pudic artery then penetrates the corpus cavernosum, and proceeds through it in a straight direction. Its ramifications appear to be distributed through the internal structure of the corpus cavernosum, and some of them extend through the septum to the other side, while others pass to the corpus spongiosum urethræ.

The External Iliac,

The great artery of the lower extremity, appears soon after birth, like a continuation of the primitive iliac, and proceeds along the brim of the pelvis behind the peritoneum, to Poupart's ligament, or the crural arch, under which it passes.

The psoas muscle is at first in contact with it on the outside, and the internal iliac vein on the inside. As it passes under

Poupart's ligament, it is immediately anterior to the psoas and iliacus internus muscles, where they are united, and the crural nerve is exterior to it. Before it arrives at the lower edge of Poupart's ligament, it sends off

The Epigastric Artery,

Which arises on its internal side, and proceeds downwards and inwards about half an inch; then it turns upwards and inwards, and continues in that direction for a small distance, after which its course is less oblique. It passes between the peritoneum and the abdominal muscles, behind the spermatic cord, and the round ligaments in females.

It generally changes its oblique direction after passing about two inches, and then proceeds in contact with the rectus, and very near its external edge, its ramifications are expended upon the anterior parietes of the abdomen; and after it has arrived as high as the umbilicus, it commonly divides into branches which often inosculate with the ramifications of the internal mammary.*

An artery which is rather smaller than the epigastric, arises nearly opposite to it, but rather lower, from the external side of the external iliac. It is called

The Circumflex Artery of the Os Ilium,

And proceeds upwards and outwards to the upper margin of the os ilium, along which it continues very near to the spine. It is distributed principally to the abdominal muscles, to the iliacus internus and the psoas, and the parts contiguous.

The artery of the lower extremity, after passing under Poupart's ligament, takes the name of

Femoral Artery,

And proceeds downwards in a direction so spiral, that although it is in front at the upper part of the thigh, it is completely behind

* Several respectable surgeons have been taught by experience, that when the abdomen is distended by ascites, the position of the epigastric artery is so much altered, that it will sometimes be found in the middle of the oblique line, which extends from the umbilicus to the superior anterior spine of the ilium.

at the lower part. It sends branches to the muscles of the thigh, as the aorta does to the viscera of the abdomen, viz. by a few large vessels which extend and ramify to a great distance among them.

The situation of the adductor muscles, and their attachment to the os femoris, is such, that the artery in this course must necessarily perforate their common tendon, which it does at the distance of one-third of the length of the bone from its lower end. The aperture in this tendon corresponds precisely with the general course of the artery; and before the artery enters this perforation, it is on the internal side of the bone; after it has passed the perforation, it is on the posterior side of it. After passing through the tendon of the adductors, it is denominated *The Popliteal Artery*, and it retains this name until it divides.

It then proceeds downwards, being very near the bone, and between the tendons of the flexors of the leg, covered by the great nerve of the lower extremity, and very often, also, by the vein. After crossing the articulation of the knee, when it is between the heads of the gastrocnemii muscle, at the lower edge of the popliteus muscle, it divides into the anterior tibial and the common trunk of the peroneal and posterior tibial arteries.

The *Femoral* artery, soon after emerging from Poupart's ligament, sends off very small branches to the inguinal glands, and other contiguous parts. It also sends off the

External Pudics,

Which are two or three small arteries that are generally spent upon the scrotum in males, and the *Labia Pudendi* in females.

About two inches below Poupart's ligament, the great branch which has been called the muscular artery of the thigh, leaves it. This vessel is commonly denominated

Arteria Profunda.

It arises from the back part of the trunk of the femoral, and passes downwards and backwards, in a way that has been compared to the separation of the internal iliac and the external. Very soon after its origin, it sends off two branches, which pro-

ceed, one on the internal, and the other on the external side of the thigh, and are called the circumflexa interna and externa. It then passes downwards behind the trunk of the femoral, and sometimes very near it, on the adductor muscles, and finally divides into branches, which are called the *Perforating.*

The External Circumflex

Sometimes arises from the femoral, but most commonly is a branch of the profunda, as above stated. It passes under the rectus and tensor vaginæ femoris towards the great trochanter, and generally divides into two branches, one of which continues in the transverse direction, and sends branches to the upper and back part of the thigh, and the parts contiguous to the joint; while the other descends in the course of the rectus femoris muscle, and some of its ramifications extend near to the outside of the knee.

The Internal Circumflex

Is often smaller than the other. It generally passes between the psoas, and the pectineus muscles, and continues round the thigh towards the lesser trochanter. Its ramifications are expended on the upper portions of the adductor muscles and the muscular parts contiguous to the lesser trochanter. It also sends branches to the articulation.

The Perforating Arteries

Are two or three ramifications of the profunda, which pass through the adductor muscles, and are expended upon the flexor muscles on the back of the thigh. Some of the terminating branches of the profunda itself are also called perforating arteries.

The next branch of importance which is sent off by the *Femoral* artery, leaves it before it enters the aperture in the tendon of the adductors, and is called

The Anastomotic Artery.

This vessel soon inclines downwards. Its ramifications ex-

tend into the vastus internus muscle; some of them follow the tendon of the adductors, and ramify about the internal condyle.

Several small branches go off from the great artery soon after it passes through the tendon of the adductors, which are distributed to the contiguous muscles. Some of them are also called

Perforating Arteries.

Among them is the principal *Medullary Artery* of the os femoris.

In the ham, the great vessels there called

Popliteal,

Generally send off several small branches. Two of them go off on the inside, one above and the other below the knee; and two on the outside in the same manner. They are named, from their situation, *The Superior and Inferior Internal,* and *The Superior and Inferior External Articulary Arteries.*

The *Superior Internal* artery perforates the tendon of the adductors above the internal condyle, and ramifies minutely on the inner side of the joint.

The *Superior External* artery passes through the lower portion of the biceps above the external condyle, and ramifies minutely on the outer side of the joint. Its superior ramifications anastomose with those of the descending branch of the external circumflex, while its inferior ramifications communicate with those of the corresponding artery below.

The two inferior arteries originate nearly opposite to the middle of the joint, and pass downwards.

The *Inferior Internal* artery passes under the internal head of the gastrocnemius muscle, on the posterior and internal side of the head of the tibia. Its ramifications communicate with those of the corresponding artery above and of the tibialis antica below. They also extend to the interior of the joint.

The *Inferior External* artery passes under the external head of the gastrocnemius and the plantaris muscle, and continues under the external lateral and capsular ligament. It is distributed on the external and inferior part of the articulation, and sends also some branches to the interior of the joint.

There is frequently an azygous vessel, called the *Middle Articular* artery, which arises from the back of the popliteal, and is distributed to the posterior part of the articulation.

The *Popliteal* artery, after this, sends off a few small branches to the heads of the muscles of the leg, and among them one of considerable length, to each of the heads of the gastrocnemii. At the under edge of the popliteus muscle, it sends off horizontally a large branch, which passes directly forward between the tibia and the fibula, above the commencement of the interosseous ligament. After this, it continues to descend, nearly in the same direction, under the soleus muscle, behind the tibia; but before it has proceeded farther than twelve or fifteen lines, it sends off a branch which forms an acute angle with it, and approaches near the fibula, along which it descends.

The branch sent off anteriorly, is called the *Anterior Tibial* artery.

The main trunk, which continues downwards, is called the *Posterior Tibial* artery;

And the branch which descends near the fibula is called the *Peroneal* or *Fibular* artery.

The Anterior Tibial Artery,

After its arrival on the anterior part of the leg, passes down close to the interosseous ligament, with the tibialis anticus muscle on the inside, and the extensor communis on the outside, in the first part of its course; and afterwards, with the extensor pollicis pedis on the outside of it. It gradually inclines internally as it descends, so that a little above the ankle it is upon the front part of the tibia. It proceeds thence with the tendons of the extensor digitorum pedis, under the annular ligament, to the upper surface of the foot, on which it continues to the interstice of the first and second metatarsal bones, where it descends to anastomose in the way presently to be mentioned.

In this course it sends off, soon after it has arrived at its anterior situation, a *recurrent branch*, which is distributed to the heads of the muscles and the ligaments of the articulation, and which anastomoses with the branches of the inferior articular

arteries. It also sends off, on each side, many arterial twigs to the contiguous muscles, and very frequently one branch of considerable size, which passes down near the fibula.

When it has arrived near the end of the tibia, it sends a branch on each side, called the *Internal* and *External Malleolar*. On the top of the foot, among several smaller arteries, it sends off a branch under the extensor brevis digitorum pedis, which passes outwards and forwards, and supplies the muscles, &c. on the upper part of the foot. This vessel is called *Arteria Tarsa*. There is also another branch, called *Metatarsa*, which generally arises about the middle of the foot, and passes obliquely outward and forward, supplying the contiguous parts.

The *Anterior Tibial* artery, having arrived at the space between the metatarsal bones of the first and second toes, bends down to the sole of the foot, but previously sends off a branch which passes near the external edge of the metatarsal bone of the great toe, and divides into two branches, one of which goes to the outside of the great toe, and the other to the opposite side of the toe next to it.

The Posterior Tibial Artery

After sending off the anterior tibial, parts with the *Peroneal* or *Fibular*, as has been already stated, and then continues on the back of the tibia, behind the internal ankle, to the sole of the foot.

The Peroneal or Fibular Artery

Is not commonly so large as either of the two other arteries of the leg, nor is it so constant. It passes down very near the internal edge of the fibula. It is in contact, for some distance, with the tibialis posticus muscle, and is anterior to the soleus and the flexor pollicis longus; it sends branches to the contiguous muscles. After it has passed along two-thirds of the length of the fibula, it frequently, but not always, divides into an anterior and a posterior branch.

The *anterior peroneal* soon perforates the interosseus ligament, and passing down some distance on its anterior surface, continues to the ankle and upper surface of the foot. It gives ramifications

to all the contiguous parts in its progress, and anastomoses with some of the small ramifications of the tibialis antica.

The *posterior peroneal branch* is the continuation of the main trunk. It passes behind the external malleolus, and ramifies upon the external side of the foot.

The *posterior tibial* artery passes down, inclining rather obliquely inwards, between the gastrocnemius internus, which is posterior to it, and the tibialis posticus and flexor digitorum, which are anterior to it. Upon the leg it gives off many small branches, one of which, termed the *Arteria Nutritia Tibiæ*, comes off high up,* and, after ramifying as it descends, sends a branch to the medullary foramen of the tibia.

At the lower part of the leg, the *Posterior Tibial* is situated rather superficially between the tendo Achillis and the tibia. It proceeds thence behind the internal ankle in a deep situation, covered by an annular ligament, and passes between the abductor muscle of the great toe and the bones of the tarsus. It then divides into two branches—the *internal* and the *external plantar* arteries.

The Internal Plantar Artery

Is commonly much smaller than the other ramification. It passes in the direction of the internal edge of the foot, but at some distance from it, and often lies between the aponeurosis plantaris and the abductor pollicis. It frequently terminates by anastomosing with one of the arteries of the great toe, and in its course sends off several branches to the contiguous parts on each side of it.

The External Plantar Artery

Is the continuation of the main trunk. It proceeds outwards and forwards between the short flexor of the toes and the flexor accessorius; and continues afterwards between the first of these muscles and the abductor of the little toe. At the metatarsal bone of the litttle toe it begins to curve, and continues its curva-

* This artery sometimes comes off from the popliteal.

ture across the other metatarsal bones to the interstice between the great toe and the one next to it, *passing between the tendons of the long extensor and the metatarsal bones.* At the interstice above mentioned, it anastomoses with the tibialis anticus. The curvature, thus formed, is called the *Arcus Plantaris.*

In this course, the *External Plantar* sends off several branches to the heel and the parts of the foot, especially on the external side; the deep-seated parts of the foot being supplied from the curve.

Digital branches go off from the curve, as they do in the hand, from the curve of the ulnar. There is first a small branch to the outside of the little toe, and then three regular branches, which pass to the junction of the roots of the four small toes, and divide, like the digital arteries of the hand, so as to send a branch to the side of each toe. These digital arteries pass between the muscle called *Transversalis Pedis* and the metatarsal bones. Near the heads of these bones, each of them generally sends off two arteries that pass upwards between the interossei muscles and the bones, and anastomose with the ramifications from the top of the foot.

The External Plantar, soon after sending off the third digital artery, anastomoses with the anterior tibial, and then continues to the junction of the root of the great toe with the one next to it, when it divides into two branches, which go to the opposite sides of those toes. In its course it also sends a branch to the internal side of the great toe.

Of the Arteries of the Lower Extremity. (*See Plate facing p.* 279.)

A. The Tendon of the External Oblique Muscle.
B. The *Sartorius Muscle.*
C. The *Gracilis.*
D. The *Triceps Muscle.*
E. The *Rectus Femoris.*
F. The *Vastus Internus.*
G. The *Vastus Externus.*
H. The *Patella.*
I. The *Tibia.*
K. The Head of the *Fibula.*

Plate IX.

C. Bell del.

L. The *Gastrocnemius Muscle.*
M. The *Soleus Muscle.*
N. The *Tibialis Anticus.*
O. The *Extensor Tendons* of the Toes.

Arteries.

1. The *Femoral Artery.*
2. The *Epigastric Artery.*
3. The *Circumflexa Ilii.*
4. A Cutaneous Branch to the head of the Sartorius, and glands, and fat.
5. To the Inguinal Glands, and Fat; it sends out a pudic branch also.
6. The *External Pudic Artery.*
7. The *Profunda.*
8. The *Internal Circumflex Artery.*
9. The *Profunda*, proceeding deep into the flesh of the thigh before it gives off the perforating branches.

The Branches of the Profunda are seen in the interstices of the Rectus and Vastus Externus.

10. The *Femoral Artery*, where it lies betwixt the triceps and vastus internus muscle, before it perforates the triceps.*

11,† 12, 13. *Articular Arteries*, branches of the Popliteal Artery.

14. The *Anterior Tibial Artery.*‡

* *Femoral Artery.* This artery, near the place of its perforating the triceps, is the subject of one of the most important surgical operations for popliteal aneurism. In dissection it may be well to make this experiment: Place a string so as to reach from the superior spine of the os ilii to the prominent part of the inner condyle; mark the middle of the string; make an incision a very little towards the inside of it, in the direction of the string; first, you come to the sartorius muscle; next, laying that aside, to a fascia, which stretches from the triceps to the vastus internus; when this is slit up you may see the artery; observe its situation in regard to the *vein*, the *nervus longus*, and the *sheath* which surrounds it.

† This branch (the first perforating branch of the Popliteal Artery) is remarkably enlarged in Popliteal Aneurism.

‡ The Anterior Tibial Artery lies so under the projection of the Tibia, that it is not often wounded; yet it may be cut by a deep wound, and the student should observe how it lies under the fascia and muscles.

"The Anterior Tibial Artery comes through betwixt the bones, one inch below the projection of the knob of the Fibula; we then cut by the edge of the *Peroneus Longus*, and follow the partition fascia, which is betwixt this muscle and the head of the *Extensor Digitorum Communis.* This partition carries us deep, and we find the artery lying on the interosseous ligament."

When the artery is to be tied lower down, after slitting up the fascia, we must cut betwixt the *Tibialis Anticus*, and *Extensor Pollicis.*

15. The Reflected Branch of the Anterior Tibial Artery.
16. The *Anterior Tibial Artery*, continuing its course, and distributing small branches to the surrounding muscles.
17. At this part it passes under the Annular Ligament.
18. The *Internal Malleolar Artery.*
19. The *External Malleolar Artery.*
20. The *Tarsal Artery.*
21. The *Anterior Tibial Artery* descending on the fore part of the foot.
22. The part at which the Anterior Tibial Artery sinks into the sole of the foot, forming communications with the Plantar Arteries.
23. The last branch of the Anterior Tibial Artery, the *Arteria Dorsalis Pollicis.*

CHAPTER IX.

OF THE PARTICULAR DISTRIBUTION OF THE VEINS.

Anatomists of great respectability have very different sentiments respecting the best method of describing the veins. Some of them, in order to follow the course of the circulation, commence with the small veins, and proceed to the large trunks which are formed by their union. Others begin with the great veins that empty into the heart, and proceed from them to the small ramifications of the venous system, in a direction the reverse of the circulation.

As the last method is the easiest for the student of anatomy, it will be adopted here; but it must always be kept in mind, that the blood flows from the small veins into the larger, and not from the latter into the former, as the mode of description seems to imply.

The great trunk of the venous system differs considerably from that of the arterial with respect to its connexion with the heart; for it communicates with that organ in such a manner, that, when viewed from before, it appears like two vessels; one opening into the upper, and the other into the lower part of the right auricle. When viewed from behind, it appears like a continued tube, three-fourths of which are deficient anteriorly; and to the margin of this deficiency the right sinus or pouch of the heart is connected.

In some preparations of the heart, where all the great vessels connected with it are much distended by the injection, and the pulmonary vessels are injected first, the right auricle is so much pressed upon from behind, by the vessels which go to the right lung, that the direction of the superior and inferior portions of the vena cava, which thus communicate with it, is altered. Each

of them is turned obliquely forwards, so that it forms an angle with the other. This occasions them to appear more like distinct vessels than they otherwise would do.

The above mentioned portions of the great veins are denominated the *Superior* or *Descending*, and the *Inferior* or *Ascending Vena Cava;* as if they were perfectly distinct and unconnected with each other.

The Coronary Veins,

Which are exclusively appropriated to the heart, may be considered here, as they are not included in the general arrangement of the veins.

The great vein of the heart begins at the lower part of the right auricle, very near to the septum, which divides the two auricles. It soon proceeds to the left in a circular direction. surrounded with adipose matter, in the deep groove which exists between the left auricle and the left ventricle. It continues between the auricle and ventricle, until it is immediately over the septum, which divides the two ventricles. Here its direction changes, and it proceeds to the apex of the heart, where its small ramifications anastomose with others soon to be described. In its course round the basis of the left ventricle, it sends off several branches, one of which is considerable, that proceed from the basis towards the apex of the heart, ramifying on the surface of the left ventricle.

A second vein, much less than the first, appears to proceed from the great vessel at its commencement,* and continues on the lower flat surface of the heart, between the two ventricles, to the apex, accompanied by a branch of the right coronary artery. This has been called the *Middle Vein* of the heart.

In addition to these there are several veins which begin at the right auricle, and extend on the surface of the right ventricle towards the apex of the heart. These have been called the *Anterior Veins.*

* It often opens into the auricle by a separate orifice.

Of the Superior or descending Vena Cava, and the veins which communicate with it.

This great vessel proceeds upwards from the superior and posterior part of the right sinus or pouch of the heart;* and a portion of it is so involved by the pericardium, that it seems to be included in that sac, as the heart is in this situation. It is somewhat anterior as well as to the right of the aorta. It continues above the pericardium, adhering to the right lamen of the mediastinum, and rather inclining forward. When it is as high as the lower margin of the upper rib, it sends off a very large branch, which conveys the venous blood of the *left* arm and the *left* side of the head and neck. This large vein, which is very important, both on account of its size and situation, proceeds in a transverse direction within the sternum, almost in contact with, and but little below, the upper and internal margin of that bone. Immediately behind, or within the origin of the left sterno-mastoid muscle, it divides into the left subclavian, which preserves a transverse course, and the left internal jugular, which proceeds to the cavity of the cranium by the foramen lacerum.

After sending off this transverse branch to the left, the great vein continues upwards and behind the right sterno-mastoid muscles, and there sends off, nearly at right angles, the right subclavian vein. After it has parted with this vein, it takes the name of *Internal Jugular*, and continues to the right foramen lacerum, in the basis of the cranium. The superior vena cava is, therefore, principally formed by the union of the subclavians and internal jugulars from each side of the body.

Immediately after the superior cava rises above the pericardium, before it divides as above stated, it sends off, from its posterior part, a large vein which is single, and, therefore, called

Vena Azygos.

This vessel projects backwards above the right pulmonary artery and right branch of the trachea, and then curves down-

* See description of the heart, vol. i. page 450.

wards behind them. It proceeds down the spine to the right of the aorta and at a small distance from it, into the abdomen, between the crura of the diaphragm, and sometimes between some of the portions of that muscle, which are attached to the dorsal vertebræ. In the abdomen it often anastomoses either with the lumbar veins or the vena cava.

The azygos frequently sends off several small veins from its curvature to the contiguous parts, and also the right *Bronchial Vein*, which passes along the ramifications of the trachea into the substance of the lungs.* In its course downwards it gives off branches to the œsophagus, some of which are considerable.

The *Inferior Intercostal Veins* originate directly or indirectly from the azygos. In some cases there is no superior intercostal on the right side; and then the two or three uppermost of the right intercostals are also derived from the azygos; and often originate from it by a common trunk, which soon divides. Most commonly the ten inferior intercostals *on the right side* proceed directly from the azygos, and accompany the intercostal arteries. Their posterior branches pass into the vertebral cavity, and communicate with the veins which are there.

About the sixth or seventh rib, the vena azygos frequently sends off a branch to the left, which descends on the left side of the vertebræ, and sends off those *left* intercostal veins which are below its origin. It passes through the diaphragm with the aorta, or to the left of it, and anastomoses either with the azygos itself, or in a way which is analogous to the anastomosis of that vessel.

The *Vena Azygos* may be regarded as the great trunk of the veins of the parietes of the thorax, which are thus collected, because they could not with convenience pass singly to the vena cava, as the arteries do to the aorta.

Soon after sending off the vena azygos, the *Superior Cava* sends off the great transverse branch above mentioned. From this it continues upwards but a short distance, when it divides,

* This bronchial vein sometimes arises from the superior cava.

behind the right sterno-mastoid muscle, into the right subclavian and right internal jugular.

The branches of the superior cava, which thus intervene between the great trunk and the subdivisions behind the sterno-mastoid muscles, are often called the *Subclavian Veins*; but they do not appear to be accurately named. For, 1st, they are not situated under the clavicle, and, 2dly, they are the common trunks of the subclavians and internal jugulars united.

There is a difference in the places where some of the smaller veins originate on each side. The internal mammary and the inferior thyroid, on the right side, arise from the superior cava, or from the subclavian at its origin. On the left side, they arise from the subclavian.

The Superior Intercostal Veins

Are somewhat different on the two sides. *That on the right* is often the smallest and the least extensive. It commonly originates from the posterior and inferior part of the subclavian opposite to the origin of the vertebral, and is generally distributed to the first and second intercostal spaces, but rarely to the third.

The Left Intercostal frequently originates near the left internal mammary, and sometimes in common with it. It descends behind the aorta on the left of the spine, and commonly sends off the six upper intercostal veins, of which the two or three superior pass upwards from a part of the vein which is opposite to the third dorsal vertebra. Its extent is very different in different subjects. In some instances it passes so low as to supply the seventh or eighth intercostal space. This vein also gives off the *Left Bronchial Vein*, which sends branches to the œsophagus and bronchial glands.

The Vertebral Veins

Arise from the subclavians, but sometimes they proceed differently in different subjects: the right passing behind, and the left before the subclavian artery of its respective side. Each of them, however, becomes contiguous to its corresponding artery.

When it has arrived at the place in the transverse processes, where the artery enters the vertebral canal, it sends off an external branch, which passes up before, and nearly in contact with those processes, and gives ramifications to the contiguous muscles, and also to the cavity of the spine. These last mentioned ramifications enter by the lateral apertures between the transverse processes, and anastomose with the veins and sinuses of the cavity. The branch often finally terminates in the lateral sinus of the dura mater, by passing through the foramen near the mastoid process of the temporal bone. The *Main Trunk* of the vertebral vein generally sends off another external branch to the muscles near the basis of the neck, and afterwards enters the canal with the vertebral artery. While in this canal, it generally sends off two branches through each of the lateral apertures between the vertebræ. One of these branches passes backwards to the muscles of the neck, and the other proceeds into the great spinal cavity, and communicates with the venous sinuses.

When it has arrived at the atlas, the *Vertebral* vein sends branches to the contiguous muscles of the neck. It also frequently sends a branch through the posterior condyloid foramen of the occipital bone to the lateral sinus.

It is evident, from these circumstances, that the vertebral vein carries a portion of blood from the sinuses of the brain and of the spinal marrow, as well as from the muscles of the neck, into the subclavian veins.

The veins of the head are frequently very different in different subjects.

The Internal Jugular,

Already mentioned, is often almost exclusively appropriated to the cavity of the cranium; and all the exterior veins of the head are ramifications of one or more smaller vessels, which pass up superficially on the neck, and are denominated *External Jugulars.* In some instances almost all the exterior veins of the head are united to the internal jugular at the upper part of the neck, and it of course conveys the blood of the exterior as well as of the interior parts of the head. Frequently these veins are

divided between the internal and external jugulars, but they are divided very differently in different subjects.

The *Internal Jugular*, however, almost always passes in the same direction from the inside of the origin of the sterno-mastoid muscle to the posterior foramen lacerum of the cranium. It is deeply seated on the external side of the common carotid artery, and under the sterno-mastoid muscle. Between the upper margin of the thyroid cartilage and the angle of the lower jaw, it often sends off branches which are very different in different subjects, but commonly pass to the anterior parts of the neck and face: above these it generally sends another to communicate with the external jugular. One of the branches which often go off from the internal jugular is that which corresponds with the superior thyroid or laryngeal artery. This vein, which has sometimes been called the *Guttural*, sends many ramifications to the thyroid gland. The *Ranular* veins, which are so conspicuous under the tongue, are also derived from it; and it likewise sends branches to the larynx and pharynx.

Before the internal jugular enters the foramen lacerum, it suffers a partial dilatation, which is generally larger on one side than the other.* This dilatation occupies the fossa at the foramen lacerum. After passing through the aforesaid foramen, the internal jugular terminates in the lateral sinuses of the dura mater.† These and the other sinuses within the cavity of the cranium are important portions of the venous system, which are interposed between the smaller branches spread upon the pia mater and the great trunks of the neck. They will be described in the account of the brain. Into these sinuses the very numerous veins of the pia mater open, proceeding to the

* When the veins of the neck are injected, it very often appears that a considerable portion of the internal jugular is much larger on one side than the other, as if it were affected with varicose distention.

It also often appears that the general arrangement of the exterior vein is different on the two sides of the head and neck.

† It is asserted that the internal coat, or lining membrane of the internal jugulars, is continued into the lateral sinuses, and extends throughout all the sinuses of the dura mater; so that the blood, during its passage through the sinuses, does not come in contact with any membrane different from that of the veins.

sinuses in a direction the reverse of that in which the blood flows in those channels.

These veins are divided very minutely on the pia mater before they enter the substance of the brain.

Into one of these sinuses, denominated the *Cavernous*, the ophthalmic vein discharges its contents. This vein proceeds from the anterior part of the sinus into the orbit of the eye through the sphenoid fissure.* Its ramifications correspond generally with those of the ophthalmic artery,† and some of them pass out of the orbit to anastomose with the branches of the facial vein.

The superficial veins of the neck are variously arranged in different persons. There is often one considerable vein,

The External Jugular,

Which is sent off by the subclavian, very near its union with the internal jugular; but sometimes it goes off from that vein much nearer the shoulder. There are sometimes two external jugulars, an anterior and posterior, nearly of equal size. More frequently one of them is much smaller than the other. In a majority of cases, the principal external jugular goes off near the junction of the internal jugular and subclavian, as above stated, and proceeds upwards towards the angle of the lower jaw, passing between the platysma myoides and the sterno-mastoid muscle. It often sends off, at the basis of the neck, one or more branches to the contiguous muscles, and then proceeds upwards. Near the angle of the jaw, it often communicates with the internal jugular: it then continues upwards, covered with the parotid gland, near the temporal artery, and finally divides into superficial and deep-seated temporal branches.

The *External Jugular*, near the angle of the jaw, often sends off the facial vein, which crosses the basis of the lower jaw, near the facial artery, and distributes branches to the side of the face and to the forehead. It also very often sends off, near this place, the internal maxillary vein, which generally ramifies in such a

* See the account of this fissure in vol. i. p. 114.

† The Vasa Vorticosa of the choroides are one of the exceptions to this.

manner that its branches correspond with those of the internal maxillary artery. Veins which correspond to some of the other branches of the external carotid artery, the lingual, occipital, &c., are often sent off near this place by the external jugular. They take the names of the arteries to which they correspond, and commonly accompany them.

The Subclavian Vein,

Although it originates differently on the two sides of the neck, is situated alike on each of them. After parting with the internal jugular, it proceeds over the first rib, under the clavicle, and does not pass between the scaleni muscles, as is the case with the arteries, but before the anterior scalenus muscle. It soon joins the great artery of the arm, and proceeds before or below it to the axilla. In this situation, it gives off branches to the contiguous parts, which correspond with those given off by the artery. In this course it also often gives off a large branch, called the

Cephalic,

Which soon becomes superficial, and proceeds downwards between the margins of the deltoid and pectoral muscles: it continues superficial on the external side of the biceps muscle, sending off many subcutaneous branches. Near the external condyle of the os humeri, it generally sends off a branch towards the middle of the anterior part of the fore-arm, which is called the *Median Cephalic,* and also some other superficial branches. It then continues over the radius, and inclining to the back of the fore-arm, until it arrives at the back of the hand, where it divides into branches, some of which go to the thumb.

In the axilla, the great vein, there called

The Axillary Vein,

Generally divides into two or three branches. One, which is commonly the largest, and appears like the continuation of the main trunk, is called

The Basilic Vein.

This vessel passes down, deeply seated, to the bend of the elbow. It becomes superficial near the internal condyle, and divides into several branches. One of these generally proceeds to join the median branch of the cephalic, and from the union of the two branches is formed the median vein, which passes down near the middle of the anterior part of the fore-arm. This vein generally sends off a branch which proceeds internally, and anastomoses with the deep-seated veins of the fore-arm.

There are frequently two other branches of the *basilic* vein. One, which is small, passes down on the ulnar side of the anterior part of the fore-arm, but does not extend to the wrist. The other passes down on the ulna, and gradually proceeds to the back of the hand, when it divides into several branches, one of which is generally appropriated to the little finger.

The *Axillary* vein, after the *Basilic* leaves it, sometimes divides into two branches, and sometimes continues undivided. In either case it accompanies the humeral artery, and takes the name of *Humeral Vein* or *Veins.* It sends off branches which correspond to those of the artery, and continues to the bend of the elbow; here it is so divided, that two of its ramifications accompany each of the three arteries of the fore-arm. These ramifications sometimes communicate with each other by anastomosing branches near the elbow, and they communicate also with the superficial veins.

The superficial veins of the arm are so different in different subjects, that a general description will rarely apply accurately to an individual case. It may, however, be observed that a Cephalic vein will generally be found, which very frequently arises from the subclavian instead of the axillary, and commonly continues to the hand on the radial side of the arm. The superficial veins, on the ulnar side of the fore-arm very frequently are branches of a large vein which accompanies the humeral artery to the elbow, namely, the basilic; but the median vein, formed by branches of the cephalic and basilic veins, is very often not to be found.

Of the Inferior Vena Cava and the Veins which are connected with it.

This great vessel exceeds the Superior Cava in diameter. It proceeds from the lower part of the right auricle, and very soon perforates the diaphragm, at a small distance in front of the spine, and rather to the right of the centre. As the pericardium adheres to the diaphragm at this place, the vessel appears to leave it abruptly. Immediately after leaving the diaphragm, it proceeds along a groove in the posterior edge of the liver, formed by the great lobe and the lobulus Spigelii.* After leaving the liver it continues downwards, inclining backwards and to the left, and is soon in contact with the aorta, which is on the left of it. It accompanies the aorta to its great bifurcation, and divides in the same manner. It sends off, during this course, branches to the diaphragm, liver, right renal glands, the kidneys, and the testicles; and also the lumbar and middle sacral veins.

The Inferior Phrenic Veins

Are thus denominated to distinguish them from other veins, which are derived from the internal mammary, &c. They generally accompany the phrenic arteries, and are distributed in the same manner.

The Hepatic Veins

Pass off from the vena cava, nearly at right angles, into the substance of the liver, while this vein is in the groove of that viscus, and before it has proceeded more than eight or ten lines from the heart.

They arise from the anterior part of the vena cava, and are generally three in number. Sometimes there are two only, but then one of them divides immediately after it enters the substance of the gland.

The distribution of these vessels in the liver has been detailed in the account of that organ, and therefore need not be stated

* Sometimes it is completely surrounded by the liver.

here; but the veins which unite to form the vena portarum, and the trunk of that great vein also, before it is connected with the liver, may be regarded as a portion of the regular venous system, and ought now to be considered.

The Vena Portarum

Passes downwards from the great sinus of the liver behind the pancreas, and inclining to the left. In this course it sends branches to the gall-bladder, the stomach and pylorus, and the duodenum. At the upper and posterior edge of the pancreas, it sends off a very large branch to the spleen, which often passes, with slight meanders, along a groove in the pancreas.

The Splenic Vein

Often sends off the *Inferior Mesenteric* vein, which proceeds downwards between the aorta and the left portion of the colon. It also sends off some of the coronary veins and the left gastro-epiploic vein to the stomach; many small branches to the pancreas; and, finally, either from the main trunk or its branches, before they enter the spleen, the venæ breves, which pass to the great extremity of the stomach. Before it enters the spleen, it forms several ramifications, which accompany the branches of the splenic artery.

After sending off the splenic, the *Vena Portarum* takes the name of

The Superior Mesenteric Vein.

Which is larger than the splenic and passes *from behind the pancreas, before the transverse portion of the duodenum*, into the mesentery; where it accompanies the superior mesenteric artery.

It is evident that the above described portion of the vena portarum simply performs the functions of a great vein; but when it takes on the arrangements for entering the liver, it no longer acts like a vein, but an artery.

The lower portion of the trunk of this vein and its ramifications is denominated *Vena Portæ Ventralis.* The part which ramifies in the liver, *Vena Portæ Hepatica.*

The Capsular Veins

Are small vessels, one on each side. That on the right passes from the vena cava to the right glandula renalis. That on the left arises from the left emulgent vein.

The Emulgent, or Renal Veins,

Are very large vessels, and, like the arteries, go off nearly at right angles, one to each kidney.

The right emulgent vein is not so long as the left, and it is rather anterior to its corresponding artery. The left emulgent, in its course to the kidney, crosses the aorta, and is anterior to it.

These veins pass to the sinus of each kidney, and ramify before they enter it. The ramifications follow those of the arteries.

The Spermatic Veins

Arise one on each side; the right from the vena cava, and the left from the emulgent vein. They proceed downwards behind the peritoneum, and on the psoas muscle generally divide into many branches, which communicate with each other as they progress downwards, and form a plexus denominated *Corpus Pampiniforme*. These branches proceed in the spermatic cord to the back of the testis. The principal part enters the body of that gland; but some of the branches go to the epididymis. In females the spermatic vein, like the artery, passes to the ovary, the uterus and its appendages, &c.

The Lumbar Veins

Correspond to the arteries of the same name. They arise from the posterior and lateral parts of the inferior cava, and those on the left side pass under the aorta.

The Middle Sacral Vein

Resembles the artery of the same name in its origin and distribution.

The *Inferior Vena Cava* accompanies the aorta to the space

between the fourth and fifth lumbar vertebræ, and there it also divides into the two

Primitive Iliac Veins.

The left vein crosses behind the artery of the right side, and rather behind the left primitive iliac artery, which it accompanies until they are opposite to the junction of the sacrum and ilium, when it divides again, like the artery, into the internal and external iliac veins.

The Internal Iliac, or Hypogastric Vein

Descends into the pelvis behind the artery, which it accompanies. Its ramifications correspond in general with those of the artery, and, therefore, need not be particularly described.

The Venæ Vesicales

Have such peculiarities that their ramifications require particular attention. They arise from the hypogastric, very near the origin of the obturator, and are large, as well as numerous.

They are somewhat different in the two sexes. In men they form a remarkable plexus on the lateral and inferior portions of the bladder, and on the vesiculæ seminales. This plexus extends more or less to the prostate; from it a number of veins proceed to the symphysis of the os pubis, which communicate in their course with the pudic vein. From thence arises the great vein of the penis, which proceeds in the groove between the corpora cavernosa, and terminates in the glans penis. This vein often divides, near the root of the penis, into two: one of which is in the groove, and the other more superficial.*

In females, the venæ vesicales form a considerable plexus on each side of the bladder and vagina. Many veins pass from these to the upper portions of the bladder and the contiguous parts, and form plexuses. The clitoris has a dorsal vein like the

* The pudic veins accompany the arteries of that name. They communicate with the plexus, as above mentioned, and continue into the penis.

penis, and it originates in a manner analogous to the dorsal vein of the male.

The External Iliac Vein.

The great trunk of the veins of the lower extremity proceeds on the inside of the artery, under the crural arch or Poupart's ligament. Before it passes from under the arch, it sends off two branches, which answer to the circumflex artery of the ilium and to the epigastric artery.

The Circumflex Vein

Arises from the external side of the iliac vein, and passes towards the anterior end of the spine of the ilium. It divides into branches, which accompany those of the artery of the same name.

The Epigastric Vein

Arises from the external iliac, and accompanies the epigastric artery. After passing a small distance inward and downward, it turns up on the inside of the abdominal muscles. In the first part of its course it sends off some small branches to the spermatic cord.

After passing beyond Poupart's ligament, the name of the great vessel is changed from external iliac to

Femoral Vein.

It proceeds downwards at first on the inside of the femoral artery, but gradually changes its relative situation, so that, in the thigh and in the ham, it is behind or on the outside of that vessel.

At a short distance below Poupart's ligament, after giving off some small branches to the external organs of generation, and to the glands of the groin, it sends off, on the internal side of the thigh, a very large vein, which is called the

Saphena Major.

This vein immediately becomes superficial, and passes down

on the internal side of the thigh, somewhat anteriorly; giving off some small branches to the contiguous parts soon after it originates; and many superficial veins afterwards. It continues along the inside of the knee and leg to the internal ankle, the anterior part of which it passes over. It then proceeds along the internal part of the upper surface of the foot to the middle, when it curves towards the external edge, and joins the lesser saphena. On the leg and foot, it also sends off many branches, which anastomose with each other, and with those of the aforesaid vein.

The *femoral* vein, after parting with the saphena, soon sends off the vena profunda, and the circumflexa also, when they do not arise from the profunda. These veins are generally larger than the arteries to which they correspond, and their branches are more numerous; but they observe the same course.

The great vein accompanies the artery down the thigh, and through the perforation in the adductor magnus; but it changes its relative position, so that it is placed behind or on the exterior side of the artery, at the lower part of the thigh. It is very often behind it in the ham, where, like the artery, it takes the name of *popliteal*. In the ham it sends off another superficial vein, which seems very analogous to the basilar vein of the arm. This is called

The Lesser or External Saphena.

It proceeds from the ham over the external head of the gastrocnemius, and down the outside of the leg, sending off many branches in its course. It passes behind the external ankle, and near the exterior edge of the upper surface of the foot, about the middle of which it inclines towards the great saphena, and forms with it the anastomosis already mentioned.

The popliteal vein, after passing across the articulation, ramifies like the artery, but sends two veins, which accompany each of the three arteries of the leg.

In a few instances, some of the larger veins have been found to be arranged in a manner very different from that which is commonly observed.

One case of this kind has already been mentioned in the account of the liver,* where the *Vena portarum* terminated in the *Vena Cava*, below the liver, without entering into it.

Another very remarkable instance of peculiar arrangement is to be seen in a preparation now in the University of Pennsylvania, in which the *Inferior Cava*, instead of opening into the lower part of the right auricle, passes behind it, in the tract of the *Vena Azygos*, and opens into the *Superior Cava*, in the place where the *Vena Azygos* usually communicates with that vessel, receiving the *Intercostal Veins* in its course.

In this preparation, the *Hepatic Veins* communicate directly with the right auricle, at its lower part; the *middle* and *left* hepatic veins forming one trunk before they enter, and the *right* vein passing in singly.†

Of the Pulmonary Arteries and Veins.

Those portions of the *Pulmonary* artery and veins which are distinct from the lungs may be described very briefly.‡

It has been already observed, that the pulmonary artery arises from the left and most anterior part of the basis of the right ventricle, and proceeds thence obliquely backwards, inclining gradually to the left side for about eighteen or twenty lines, when it divides into two branches, which pass to the two lungs. This course places it under the curve of the aorta: for

* See note to p. 93, of this volume.

† The foregoing preparation was made by the present editor in 1814, since which two other anomalous cases have occurred to him.

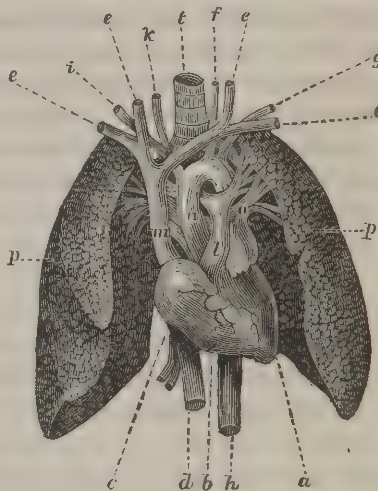
1819. Case 1st. The ascending cava passed into the thorax on the left side of the spine, and getting as far as its upper part, was joined there by the trunk of the internal jugular and subclavian of the left side. It there passed across the vessels of the arch of the aorta and joined with the descending cava. The vessels of the liver entered the heart at the usual place, in the lower part of the right auricle.

1820. Case 2d. The trunk formed by the junction of the internal jugular and subclavian of the left side, instead of taking its usual course, passed down vertically, before the left branch of the pulmonary artery and before the left auricle, then making a slight curve between this auricle and the diaphragm joined with the ascending cava.—H.

‡ See Fig. 71, page 298.

that great vessel passes over the right branch of the pulmonary artery, and the right side of the main trunk of it, in such a manner that it proceeds downwards between the two branches and behind the angle formed by their bifurcation. From this place of bifurcation a short ligament proceeds to the lower part of the curve of the aorta, which is almost in contact with it. This ligament was originally the canal that formed the communication between the pulmonary artery and the aorta of the fœtus. Each of the great branches of the pulmonary artery takes a direction backwards, and to its respective side. It soon joins the corresponding branch of the trachea and the two pulmonary veins, being anterior to the branch of the trachea, and above the pulmonary veins. It is also invested, in common with them by that portion of the pleura which forms the mediastinum, and thus enters into the composition of the root of the lungs.

Fig. 71.*



* Fig. 71.—*a*, Left ventricle. *b*, Right ventricle. *c*, Right auricle. The left auricle is seen above the left ventricle of the same side. *d*, Vena cava inferior. *e*, Subclavian and jugular veins; those of the left side unite to form the vena transversa; those of the right, to form the vena innominata; the junction of these larger trunks, constitute the vena cava superior or descendens. *f*, Left carotid, *g*, Left subclavian artery, arising from the arch of the aorta. *h*, Descending aorta. *i*, *k*, Right subclavian, and right carotid, given off from the arteria innominata, which is seen arising from the arch of the aorta. *l*, Pulmonary artery, dividing into two branches, one for each lung—the left passing in front of the descending aorta, the right behind the aorta, where it begins to form the curve. *m*, Vena cava superior. *n*, Aorta. *o*, Left pulmonary veins, entering auricle of same side. The right pulmonary veins, are seen on the opposite side. *p*, *p*, Lungs. *t*, Trachea.—P.

The *Pulmonary Veins* are four in number—two on each side. In conformity to the mode of description which we have adopted, it may be said that they arise from the sides of the *Left Auricle*, and proceed nearly in a transverse direction, two of them to each lung; where they accompany the branches of the artery and of the trachea, being invested by the mediastinum, in common with these branches. It has been observed that they differ from veins in general, by preserving a diameter nearly similar to that of the arteries which they accompany.

PART IX.

GENERAL ANATOMY OF THE ABSORBENT SYSTEM.

THE absorbent vessels are small transparent tubes, of a delicate structure, which exist in considerable numbers, in almost every part of the body.

These tubes originate upon the surfaces of all the cavities of the body; and of the cellular membrane, in all the various parts into which it penetrates; upon the internal surface of the stomach and the intestines; and probably upon the skin.*

—The *Absorbent System* is frequently described under the name of the *lymphatic;* but this latter term is not so appropriate as the former, as a generic name, since it applies only to that portion of the system spread pretty generally through the body, whose office it is to take up the serous and other substances (lymph) which are found in the midst of the organs exterior to the cavities of the sanguineous capillaries; whilst another portion called the *lacteals*, originate from the villous surface of the intestinal canal, for the purpose of taking up and transporting the product of digestion under the form of chyle. Both the lacteals and proper lymphatics, however, are precisely similar in respect to structure, unite together so as to form common trunks, and discharge their contents by a common orifice into the venous system.

—The existence of the absorbent system was unknown to the ancients: for although Herophilus and Erasistratus discovered parts of it in their dissections of large animals, at Alexandria in Egypt, they were perfectly unconscious of the peculiar functions it performed in the economy; and so little worthy of attention was their

* See vol. i. p. 387.

discovery deemed, that Galen and his followers, down to the middle of the sixteenth century, believed that the whole function of absorption, even that of the nutritive materials, was performed by the veins. In 1565, Eustachius observed the thoracic duct in the horse, which he believed to be a vein, and named *vena alba thoracis.* The chyliferous vessels were first discovered in 1622, by Gaspard Aselli, Professor of Anatomy at Pavia, while making the dissection of a living dog in the presence of some friends, and were seen for the first time in man by Gassendi, in 1628. In 1649, Jean Pecquet observed anew the thoracic duct, while dissecting a living dog, showed it to be the common termination of the chyliferous vessels, and was the first to suggest that they formed a distinct system of vessels.

—Up to this time, the lacteals and thoracic duct, only had been the subject of observation, and the existence of the general lymphatic system had not even been suspected. The honour of having discovered the general lymphatics, has been warmly contested by three men, Olaus Rudbeck, a young Swedish anatomist, Thomas Bartholine, a Dane, and George Jolyff, an Englishman. To Rudbeck it is now generally admitted to belong, who observed them in 1651, and in the following year, demonstrated them publicly before the young Queen Christina, of Sweden. Since that time this interesting department of anatomy has had many zealous and successful cultivators, among whom may particularly be mentioned, Ruysch, Meckel, Lieberkühn, the Hunters, Hewson, Monro, Cruikshank, Sheldon, Sömmering, Schreger, Werner, Haase, and Mascagni; and more recently, especially in the field of comparative anatomy, in Fohman, Lauth, Lippi, Rossi, Panissa, Arnold, Müller and Breschet.

Comparison between the Absorbent Vessels and the Veins.

—The absorbent vessels like the veins, constitute an immense system, which originate as minute tubes in all portions of the body, run from the circumference to the centre, and converge into two or more canals of considerable size, which open into large venous trunks. Like the veins, also, the absorbents are di-

vided, into two portions or couches; a *superficial*, which is spread extensively immediately under the skin, and accompanies in general the superficial veins of the limbs; and into a *deep-seated* or profound, which accompany the deep-seated arteries and veins. Like the veins, too, the absorbent vessels are provided abundantly with valves.

—Here the analogy between the two systems of vessels cease. The absorbents differ from the veins, in having their course interrupted from time to time, by the lymphatic glands; by the mode in which they run, not uniting successively into branches and into trunks like the veins, but each running as it were an independent course from their origin to near their termination, and not enlarging much in diameter, though they anastomose frequently with each other. The fluid which circulates in the veins, is yet, though in a diminished degree, under the influence of the heart (*vis a tergo*); the fluid of the absorbent vessels, appears to be exclusively under the influence of the walls of the vessels themselves. The origin or radicles of the veins have been clearly shown by the microscope, to be from the arteries through the intervention of the capillary vessels; whilst the origin of the absorbents though yet involved in much obscurity, on account of their tenuity and the transparency of the fluids which they carry, is believed to be wholly different.—

The absorbents which originate in the *Lower Extremities* and the *Cavity of the Abdomen*, unite and form a large trunk called the *Thoracic Duct*, which proceeds through the thorax, and terminates in the left *Subclavian Vein*, at its junction with the *Internal Jugular*. Those of the *Left Upper Extremity*, the *Left side of the Head*, and the contiguous parts, form a trunk which terminates in the same place. While the remaining absorbents, or those of the *Right Upper Extremity* and the *Right side of the Head, &c.* also form a trunk which terminates in the corresponding part of the *Right Subclavian Vein.*

The absorbent vessels of the middle size, which arise from the union of the small vessels, and unite to form the larger, in their progress to these large vessels, pass through certain bodies

which have been denominated *Conglobate Glands*, and may be considered as appendages of the absorbent system.

The absorbent vessels are composed of two coats, which are thin, but dense and firm, and also elastic. The coats of the thoracic duct may be separated from each other. The internal surface of the exterior coat is fibrous. The internal coat is a delicate but strong membrane. There is great reason to believe that the above mentioned fibres are muscular, or at least irritable; for the absorbent vessels have been observed, by Haller, to contract upon the application of strong sulphuric acid. They have also been observed to propel their contents with considerable rapidity, by their own contraction, independent of pressure, or of motion communicated by any other body.

Blood-vessels are sometimes observable in the coats of the larger absorbents, in injected subjects. The vascularity of these tubes may also be inferred from the inflammation which frequently takes place in them.

Nerves have not been traced into their texture; but the absorbents seem to be painful when they are inflamed, and, therefore, it is probable that they are supplied with nerves.

The absorbent vessels are very generally supplied with valves, which are much more numerous in some of them than in others; and are different in their number, in the same vessels, in different subjects.

Very frequently there are several valves in the course of an inch: sometimes a valve will not appear in the course of several inches. In the *Thoracic Duct* the number of valves is very different in different subjects. These valves are folds or plaits of the internal membrane, and are of a semicircular form. There are commonly two of them together originating from opposite sides of the vessel.

The absorbents are generally somewhat dilated on the side of the valve which is next to their termination, and this occasions their knotted appearance when they are injected. The object of this valvular structure seems to be the prevention of retrograde motion of the contained fluid, in consequence of lateral pressure.

Where the different trunks of the absorbents open into the veins, there are one or two valves to prevent the regurgitation of the blood into them.

The valves of course prevent the injection of the branches of these vessels from their trunks. In some animals the valves have sometimes been ruptured, or forced back; and the absorbents have been injected in a retrograde direction. There are but two or three instances upon record where this has been practicable in the *Human Subject.*

In consequence of the impracticability of injecting the small branches from the larger, the absorbent vessels cannot, generally, be demonstrated at their commencement, or origin. It is, however, to be observed, that the *Lacteals*, or *Absorbents of the Intestines*, appear no way different from other absorbents; and they have been seen distended with chyle, from their commencement, in certain subjects who had died suddenly. Their origins have been described very differently by different observers.

Mr. Cruikshank describes them as originating on the surfaces of the *villi*, by a number of very small radiated branches with open orifices; which branches soon unite to form a trunk.

Lieberkühn believed them to commence in the form of an ampullula. (See page 43 of this volume.)

The second Monro also believes that the absorbents begin by very small tubes, with open orifices in several species of fish.*

It is stated by Dr. Sömmering, upon the authority of Haase, a German anatomist, that when mercury is forced backwards in the absorbent vessels of the foot and the heart, it has sometimes escaped on the surfaces of those parts. The probable inference from these facts is, that those vessels originate by open orifices on the surfaces of the heart and foot.

Origin of the Absorbent Vessels.

—Mascagni, who devoted the greater part of his life to the

* See his work on the Structure and Physiology of Fishes, p. 34.

study of the absorbent vessels, was able to demonstrate their existence in every part of the body, with the exception of the substance of the brain, the spinal marrow, the eye, bones, placenta, and umbilical cord. Within a recent period Fohman* has succeeded in detecting them on the surface of the encephalon, in the meninges, in the plexus choroides, in the placenta, and in the umbilical cord; Arnold† has seen them upon many of the tissues of the globe of the eye; and Cruikshank, Sömmering, and Bonamy,‡ have succeeded in tracing them into the interior of the bones. There can, therefore, at the present moment, be no doubt of their general distribution throughout the body.

—On the surfaces of the different membranes of the body, these vessels have, however, been found to be most numerous, and Mascagni was induced to believe that these membranes, and especially the serous and the cellular, the latter of which forms the web-work of the whole body, consisted of a net-work of absorbent vessels. But he does not explain himself clearly in regard to the point in question, viz. the mode in which these vessels have their origin.

—The great difficulty in determining this question in man and the superior animals, is the obstacle which the valves present to the injection of mercury backwards and towards their roots: for if this could be effected, as it has been in the excretory ducts of the glands, the anatomist, by the aid of the microscope, would probably soon be enabled to solve the difficulty, and especially, as there is reason to believe that the radical absorbents have a diameter superior to that of the sanguineous capillaries. In the absence, therefore, of all positive knowledge upon the subject, there has been much room for speculation;—some believing them to originate from the arteries,—some by open mouths or gaping orifices,—and some by a net-work, in which the vessels, tracing

* Memoires sur les Vaisseaux Lymphat. etc. etc. Liege, 1833; and, Sur les Vaisseaux Absorb. du Placenta et du Cord Umbilicale.—P.

† Anatomische und Physiol. Untersuchungen uber das Auge des Menschen. Heidelburg, 1832.—P.

‡ Cruvielhier Anat. Spec. T. iii.

them towards their origin, seem to anastomose again and again with one another.

—The first opinion was derived from the fact first noticed by Cowper, Cheselden, and Férrein, that in making delicate injections of some parts of the body, the injecting matter, will pass occasionally from the arteries into the lymphatics; and Breschet* has observed the same thing to occur when an injection has been pushed at the same time in several of the smaller branches of the veins, in the direction of their roots. The researches of Panissa,† Müller, and others, have shown that this takes place but sparingly in any part of the body, and in general, only when considerable force is used, and that in some portions it cannot be effected at all. So that this communication with the arteries, cannot be looked upon as the common origin of the absorbents, which are so very numerous; and in many instances is most probably produced by a laceration of the tissue from the force of the injection, by which some of the injected fluid insinuates itself into a ruptured absorbent vessel, or by a passage through the pores in the parietes of the vessels, as Fohman has suggested.

—The origin by open mouths or gaping orifices, which has been maintained by Lieberkühn, Cruikshank, Cruvielhier, Magendie, etc., and only with respect to the lacteals, does not appear to be better founded, and is probably produced by a laceration of the parts; since Rudolphi, Panissa, Breschet, Fohman, and Lauth, in experiments made expressly to determine this point, have never observed it as a normal state, either in the injection of dead bodies, or in the microscopical observations of the transparent parts of living animals, or in observations like that of Cruikshank, made by Lauth and Krause, on the lacteals of a human subject, that were found distended with chyle. (See vol. ii. p. 67.)

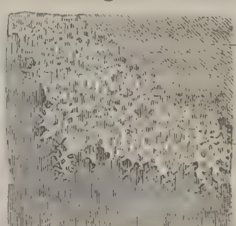
—The mode of origin by a mesh or net-work, is not only that which is best supported by the concurrent testimony of recent observers, but appears also to have been that supported by Mascagni. This appears to be demonstrated by the three only

* Le Système Lymph. etc. par G. Breschet. Paris, 1836.—P.

† Osservationes Antrop. Zootomico Fisiologiche. By Prof. Panissa. Pavia, 1833.—P.

modes in which the capillary absorbent vessels have been made obvious to the eye. That of Mascagni, in which a serous cavity was filled with a coloured fluid, with which the absorbents of the lining serous membrane filled themselves, and thus became visible; that of Lauth, which consisted in filling the minute absorbents with mercury, and gently pushing it with the handle of a scalpel towards their capillary extremities, in which, as in the veins, the valves cease to exist; and that of Cruvielhier and others, which consists in puncturing superficially the surface of the skin, or of the mucous and serous membranes, with the point of a mercurial injecting tube, when the mercury will be seen gradually to dilate the orifice into a little sac, and then to insinuate itself into the absorbent vessels. The absorbents injected by either of these modes appear to constitute a dense net-work or plexus of vessels, which communicate on the opposite side of the membrane with larger absorbent trunks, in which valves begin to be visible. From the injected membrane, the cuticle of the skin, or the epithelium of the mucous tissue may be removed by maceration, without liberating the mercury, which is thus shown to be confined not merely in the cells of the cellular tissue, but in a system of tubes.

*Fig. 72.**



—Fig. 72, is a specimen of the lymphatics of the mucous membrane of the stomach, prepared in this way after Breschet; and Fig. 73, page 311, of the lymphatics of the mucous surface of the glans penis, and of the skin of the scrotum. The vessels thus injected present very much the appearance of a mesh of arteries and veins, for which, no doubt, they have been sometimes mistaken.

—But the lymphatic net-work is evidently seated above the blood-vessels, for if the latter be subsequently injected, they never rise up so as to cover the former; and where the blood-vessels

* Fig. 72, is a representation of the origin of the absorbents of the stomach, after Breschet. *a*, Superficial layer. *b*, Deep-seated layer.—P.

have first been filled, the lymphatics may be subsequently injected above them. In the mucous membranes provided with epithelium, the situation of the superficial absorbent net-work is precisely the same as in the skin; but in mucous membranes unprovided with epithelium, or rather in which the epithelium exists in a state of undried mucus, the situation of the lymphatic net-work is more naked, a condition which is eminently favourable for the accomplishment of the function of absorption.

—Each of the villi of the mucous membranes, are now believed to be nothing more than delicate elevations of the mucous membranes, comprising separate loops of the sanguineous and absorbent vessels, and probably nervous fibrils, covered by mucus. The lymphatic vessels have the same mode of origin in the lining membrane of the cavities of the heart, as well as on the exterior of that organ as has been proved by Lauth, Bonamy, and Cruveilhier,* who succeeded in injecting them.

—The origin of the lymphatic vessels, from the midst of the nervous, muscular, and glandular structure, is not, from the very nature of the parts, easily susceptible of demonstration. Nothing positive, therefore, is known in regard to it, and it is most probable that Mascagni was right in his suggestion, that the numerous vessels which issue from the parts, originate in the cellular tissue which form the woof of the organs.

—The origin of the *lymphatics* from the cellular tissue and serous membrane, which is but a modification of the cellular, is certainly more general than that from any other tissue of the body, and there is much reason to believe, that it is the principal point from which they arise—the soil in which their radicles are found; and in the different organs of the body where lymphatics are known to originate, it is most probable, though not yet fully demonstrated, that it is from the cellular woof that they take their rise. In fact, the organs in which this tissue does not enter, are the only ones from which no lymphatics originate, viz. the nails, horns, epidermis, ivory of the teeth, etc. Mascagni† and Cruvielhier have observed, in respect to the cellular tissue and the

* Anat. Speciale, tom. iii.—P.

† Vasor. Lymph. Corp. Human. Hist. et Iconogr. Sienne, 1787.—P.

serous membranes, so many lymphatics in their combination as to be induced to believe that they are formed of lymphatics. The microscopical researches of Fohman, Arnold, and Treviranus upon this subject, have led them nearly to the same conclusion; the two first believing that the cellular tissue acts the part of a sponge to the absorbents which have their radicles in it, and that its filaments are probably composed of very minute elementary lymphatic vessels. Treviranus,* in some very recent observations in comparative anatomy, (especially in the tortoise) has satisfied himself, by the use of a glass of very great magnifying powers, that the absorbents take their origin in the cellular tissue which is composed of elementary cylinders, closely interlaced together, some twisted, some zigzag in shape, and of such minuteness as to have a diameter only the 0.0016, to 0.0002 of a millimetre.† Some of these unite together, and form larger cylinders, which go out from the mass, unite with others of the same kind, and thus form trunks of 0.001 to 0.0023 of a millimetre in diameter, which have the appearance of lymphatics, and open into the lymphatic vessels. Thus he believes, that when ultimately analyzed, the lymphatic vessels will be found to originate on all the free surfaces of the body, in the midst of the tissues, as well as in the intestinal villi, by elementary tubes belonging to the cellular tissue, which constitutes the basis or web-work of the organs, and which tubes have appeared to him on the villi and free surfaces of the body, to terminate in vesicles which seemed in some parts to be pierced with a hole.
—However the facts may hereafter be found to be, in regard to these researches of Treviranus, for the high magnifying powers employed would necessarily render him liable to optical illusions, we are fully justified, at the present advanced stage of anatomical science, in considering the absorbents as not arising either from the arteries or veins, but as separate vessels in the meshes of the cellular tissue, which divide, unite, re-divide, and anastomose together, again and again, till they seem to occupy the whole

* Bertrage Zur Aufklaerung der Erscheinungen und Gesetze, der organitschen Lebens. 1836, page 100.—P.

† A millimetre equals the 0.039379 part of an English inch.—P.

mass of the tissue, and convert both the proper cellular and serous membranes, into mere spongy absorbing surfaces.

—It would seem that absorption took place in consequence of the permeability of this net-work structure of the tissues to the fluids in which the absorbents are bathed, (as has been so clearly shown by E. Edwards* to be the case in the amphibiæ,) whether the fluid consists of effused serum, escaped through the pores of the blood-vessels and mixed up with the effete molecules of the organs, or of ecchymosed blood, or of purulent collections; and that this permeation is aided by an attraction through the walls of the vessels into their interior, called *endosmosis* by Dutrochet, where the fluid is placed under the influence of the absorbents, and is passed onwards towards the thoracic duct. If the assertions of Treviranus should be found correct, it might be considered as being pumped up through a series of the minutest capillary tubes.

—The contractility of the absorbent vessels is very evident, and exists even for many hours after death, as may be seen by opening an animal shortly after it has been killed. Their force of resistance is also very considerable compared with the arteries and veins of the same diameter.

—In the inferior extremities it is considered to be to that of the arteries in the proportion nearly of 10 to 3. These vessels are very elastic, and one which is almost imperceptible to the naked eye, becomes, when fully distended with mercury, half a line in diameter.

—This elasticity resides in the external coat of the vessels, which is no longer considered muscular, but as a sort of yellow elastic tissue, somewhat like the structure of the dartos, which allows the lymphatics to extend themselves to a great degree without breaking, and subsequently to return upon themselves and propel their fluid contents onwards.

—*Absorbent Glands* do not exist at all in reptiles and in fishes. The first trace of them is met with in birds, where they are formed merely by the absorbent vessels, interwoven and reticulated in the form of plexus. In man, their structure appears in fact to be the same, but the meshes are minute. Many anatomists, as

* De l'Influence des Agens Physiques sur la Vie, etc.—P.

Fig. 73.*

Malpighi, Cruikshank, and Werner, believed there existed particular follicles, forming round cells, with their walls in the in-

* Fig. 73—Represents the inguinal region of a young infant, the prepuce slit open, in order to expose the glans, (from Breschet.) *a*, *a*, Two of the superficial inguinal lymphatic glands, *b*, *b*, Efferent lymphatic vessels, filled with mercury, terminating in these glands. *c*, *c*, The same lymphatic vessels, laid bare in the groin, to exhibit their course in the subcutaneous cellular tissue. *d*, *d*, The same vessels penetrating the tissue of the skin, where, by their ramifications and anastomoses, they form a dense net-work, *e*, *e*, which, properly speaking, constitutes their origin. This net-work is on the exterior face of the cutis vera, and is covered only by the epidermis. *f*, *f*, Arterial branches, distended with fine coloured injecting matter, in order to render it certain that the vessels filled with mercury, are lymphatic, and not sanguineous vessels. The termination of these vessels in the lymphatic glands, moreover, prove their character. *g*, *g*, Prepuce slit open on its upper part, in order to show its internal face, upon which is seen a beautiful net-work of lymphatics in the cutaneous tissue, which is here modified so as to appear like mucous membrane. *h*, *h*, Net-work of lymphatics in the mucous membrane covering the glans penis. The efferent vessels of the two inguinal glands are not seen in this figure, as they arise from the opposite side of the glands, and run deep to get into the cavity of the abdomen, below Poupart's ligament.—P.

terior of the glands, with which the vasa *inferentia* and *efferentia* communicated, and upon which the blood-vessels ramified; but nearly all modern anatomists who have investigated this subject, adopt the opinions of Ruysch, Hewson, Meckel, and Mascagni, that these cells are nothing but artificial dilatations of the absorbent vessels, and that the entire structure of a lymphatic gland consists of convoluted lymphatic vessels, densely arranged, and anastomosing freely together, over which arteries and veins ramify, the whole being embraced by common cellular tissue, in the form of a capsule.

—Magendie has called the attention of the profession to a fluid peculiar to the mesenteric glands, and which was known previously to anatomists under the name of the *succus proprius.* But Lauth has shown that this fluid does not exist in the interlobular cellular tissue, and is in fact but a part of the common contents of the blood-vessels, and found in all the other lymphatic glands.

—The absorbent glands are softer and larger in children and young persons than in adults, and seem to diminish in number in old men. There is nothing in this fact, according to Lauth, that should surprise us, since the glands are made up only of convoluted vessels, which, like the sanguineous capillaries, become less and less active, and are here and there obliterated in the atrophy attendant upon extreme old age.

—It is as yet considered very doubtful, whether the absorbents have any communication with the secreting ducts of glands. In injecting the excretory ducts of the glands with mercury, especially those of the mamma, testicle, and liver, it is very usual to find some of it escaping into the absorbent vessels. This, which, to all appearance, would seem to prove their direct connexion, is notwithstanding considered by many distinguished anatomists, as caused by a rupture of some part of the glandular structure, and that the mercury found its way into the openings made by the laceration in the absorbent vessels. But the communication between these vessels and the excretory ducts, takes place so readily, in the injection of the latter, and so much without the appearance of extravasation, as to render it most probable that there exists some anastomosis between them. The same degree of

doubt exists in regard to the connexion between the absorbents and small veins. It has been chiefly alleged to exist between them, in the excretory glands of the body, and in the absorbent glands themselves; in all which parts, the friability of their structure renders them liable to laceration, by the pressure from a mercurial column, or by ordinary minute injection thrown in with force. Though the fact is very evident, that many of the absorbents may be filled by injection of the ducts of the secernent glands, and that mercury passes with extreme facility from the lymphatics of the absorbent glands into the veins, the weight of testimony, is certainly at present in favour of its taking place only in consequence of a laceration of tissue. The statements of Lippi,* in regard to the free communication, which he has described between the lymphatic vessels and veins, are now disregarded, in consequence of its having been shown by Fohman, Panissa, and Breschet,† that he had mistaken in his investigations capillary veins for lymphatic vessels.

—The opinion in regard to the *termination of the absorbents*, since the many alleged venous communications of Lippi have been disproven, has reverted now to that entertained formerly, by Hewson, Cruikshank, and others; namely, that the absorbent and venous systems, can be considered as connected only by the principal lymphatic trunk, the thoracic duct, which opens into the left subclavian vein, and by the right brachio-cephalic, and other branches, which open into the internal jugular and subclavian of the right side. All other communications which take place between them may be received as exceptions to the normal structure.

—The most frequent of these, are the branches between the thoracic duct, and vena azygos. In many amphibia and reptilia, lymphatic hearts, or contractile dilatations of the absorbent vessels, have been discovered by Müller, which assist in the circulation of the lymphatic fluid.‡ Nothing analogous to them, has, however, been discovered in man.—

* Illust. Fisiol. e Pathol. del Sistem. Limfat. Chil. etc. Firenze, 1825.—P.

† Vide Breschet, sur la Systême Absorbant.

‡ See an interesting paper on this subject by Dr. Allison of Philadelphia—Amer. Jour. Med. Science, Aug. 1838.

The bodies connected with the absorbent vessels, which are called *Conglobate Glands*, are generally of a roundish, or irregular oval form, and somewhat flattened. They are of various sizes, from two lines in diameter to more than twelve. Their colour is frequently whitish, but sometimes it is slightly inclined to red. They are invested with a covering of cellular membrane, which appears like a membranous coat; and they are connected to the contiguous parts by a loose cellular substance. When the absorbent vessels connected with these bodies approach near to them, they divide into a number of ramifications, most of which enter into the substance of the gland, while some of them run over it. On the opposite side of the gland a number of branches go out, which unite and form trunks similar to those which entered the gland. The vessels which enter the gland are called *Vasa inferentia*, and those which go out of it *Vasa efferentia.*

These vessels are generally much convoluted in the substance of the glands, so that those bodies sometimes appear like a mere convolution of absorbent vessels. There has been much diversity of sentiment respecting the structure of these organs.*

The absorbent vessels, in the different parts of the body, generally contain fluids resembling those which are found in those parts. Mr. Hewson opened the large absorbents in many living animals of different kinds, and found that they contained a transparent fluid, which coagulated when exposed to the open air.

The arrangement of these vessels resembles that of the veins in several respects. Many of them are superficial; but there are also deep-seated absorbents which accompany the blood-vessels.

Of the Chyle.

—Under this name we designate the fluid, carried by the ab-

* Mr. Abernethy states, that the mesenteric gland of the whale consists of large spherical bags, into which a number of the lacteals open. Numerous blood-vessels are ramified on the surfaces of these cysts; and injection passes from them into the cyst. He also found cells in the glands of the absorbent vessels, in the groin and the axilla of the horse. See Philosophical Transactions, for 1796, Part I.

sorbents of the intestinal canal *during digestion ;* in the intervals of digestion, the trunks of the same vessels in the mesentery are filled only with the ordinary lymph. These vessels of the intestinal canal are called lacteals, in consequence of their white appearance when distended with chyle. The lymph proper, is a fluid taken up by the radicles of the general lymphatic system, and is mixed with the chyle in the thoracic duct. Chyle is limpid in birds, a little opaque in herbivorous animals, and very opaque in the carnivorous, including man. The opacity of the chyle, appears to depend upon the great number of globules suspended in it, which appear to be round in birds and all the mammalia, notwithstanding, the blood globules are elliptical in birds, and flattened in man. (See vol. ii. p. 218.) According to Müller, the chyle globules are to be found in the first radicles of the lacteals, as he saw them distinctly in the calf; this favours the opinion that they are not formed in the vessels themselves, but are probably taken in in the state of globules during digestion, and are probably the results of the disintegration of the alimentary matter, by the digestive process. The chyle has a spermatic odour, an alkaline taste, and varies in many respects, according to the nature of the aliment subjected to the action of the digestive organs. According to Magendie, Tiedemann and Gmelin, the chyle from aliments containing an abundance of fatty matter, is very white and full of oily particles, which, when the fluid is drawn from the vessels, float on its surface like a sort of cream: while that formed from food possessing little or no fatty matter, is more opaque, and exhibits but little or no creamy covering upon its surface.

—The chyle evidently undergoes a change as it ascends in the thoracic duct. It exhibits more and more of a rose tint in place of its creamy colour, and is more coagulable and more assimilated in appearance to the blood, the nearer to the top of the thoracic duct, that we extract it for examination *during the act of digestion.* During that period the duct is filled chiefly with the contents of the lacteal absorbents, but little of the general lymph of the body, being at that time transported to the duct. When withdrawn from the duct, chyle coagulates of itself, and

the action of the air heightens greatly its rosy hue. The coagulation takes place in this fluid, from the same causes that it does in the blood; from the fibrine which exists in a state of solution in the recent chyle, returning to the solid state, and inclosing a part of the globules.

—The serum in which the coagulum floats, is a solution of albumen, containing likewise some of the globules, and at the same time, has floating upon its surface a layer of fatty particles. In the lungs, where the chyle passes, mixed with the venous blood, the final change is effected, so that the chyle can no longer be distinguished from the sanguineous fluid. The opaque colour of the chyle in the lacteals, according to Tiedemann and Gmelin, is dependent not only upon the number of the globules it contains, but in part, also, upon the minutely divided particles of fat which are suspended in it.

Of the Lymph.

—The term lymph has been very loosely applied by anatomists and physiologists, not only to the fluids of the lymphatic vessels, but to the serum of the blood, to the transparent fluids of the serous cavities, and to many albuminous and fibrinous exudations. Latterly it has been more appropriately confined to the contents of the general lymphatic system.

—It has been collected for examination from the thoracic duct, and from the absorbent trunks of the upper extremities, head, and neck, in many animals after several days starvation, when no materials had been afforded for the formation of chyle; it has also been very recently obtained by Müller, from the human subject, in the case of a young man in the hospital at Bonn. This individual had received a cut on the back of the foot which could not be made to cicatrise, and the divided absorbents threw out, when pressed upon, a large quantity of lymph, which was transparent, inodorous, saline to the taste, with alcaline properties, and which, in about ten minutes after being collected, formed a delicate coagulum resembling a spider's web. The lymph, when examined with the microscope, presented many globules, much less abundant, however, and smaller than those of

the blood. During coagulation part of these globules, were inclosed in the clot, but the greater part were suspended in the serum.

—The coagulation was evidently produced by the solidification of a substance previously fluid, which is considered to be fibrine, and which, in passing to the solid state, enveloped a certain portion of these globules, that was before free.

Comparison between Chyle and Lymph.

—Both contain globules; but they are few in number in the lymph, and abundant in the chyle. Both contain fibrine in solution. The most important difference between these fluids, consists in the fatty matter, which the chyle holds in solution, and which does not exist in the lymph. The other constituents, fibrine albumen, salts, etc., are much the same in both.

—In regard to the disposition of the colouring matter which is generally found in chyle, and sometimes even in lymph, whether it is in a state of general solution, or attached to the globules, as in the case of the blood, we literally, as Breschet, has observed, know nothing as yet. Between these two fluids there are, as may be observed, many points of analogy with the blood. The chyle contains new globules formed by the digestion and disintegration of the alimentary matter, and which are destined, when they have received the last finish of assimilation in their passage through the lungs, to constitute the nuclei of the red particles of the blood.

—The lymph also contains globules formed from the wreck of the old materials of the body, as they exist in the molecular state, in the different tissues of the body; the size of which globules, as has been shown by some observers, is about equal to that of the nuclei of the red particles of the blood, and which are destined to be thrown out from the body, as being worn out and worthless, or to be reinstated by the action of the lungs, into the same condition that they were formerly, before they had been deposited from the blood to constitute the atoms or molecules of the different organs.

CHAPTER X.

OF THE ABSORBENTS OF THE LOWER EXTREMITIES, THE ABDOMEN. AND THE THORAX.

UNDER this head are arranged the ramifications of all the vessels which unite to form the *Thoracic Duct.*

Of the Absorbents of the Lower Extremities.

These absorbents, like the veins, are superficial and deep-seated. The *superficial* lie in the cellular membrane, very near the skin; and form an irregular net-work which extends over the whole limb. They are, however, most numerous on the internal side.

The *deep-seated* accompany the arteries like the veins, and there are two at least to each artery.

The Superficial Absorbents

Have been injected from the toes so as to form a net-work, which occupies the upper surface of the foot. They have also been injected in a similar manner on the sole. Those on the upper surface of the foot generally proceed upward on the anterior and inner side of the leg; but some of them pass on the external side of it. Those on the sole are continued on the back of the leg, but communicate very frequently with the anterior vessels. Some of the absorbents from the outside of the foot and leg enter into some of the popliteal glands, soon to be described; but they are not numerous; and the principal number continues up to the glands of the groin. The absorbents which originate on the suface of the thigh, as well as those which pass over it from below, incline gradually along the anterior and posterior surface, to the internal side of it; on which they proceed in great numbers, and very near to each other to the inguinal

glands. Superficial absorbents proceed also from the buttock and lower part of the back, from the lower part of the abdomen, the perineum and the exterior of the genital organs, to these glands.

The Deep-seated Absorbents

Are named from the arteries they accompany.

The Anterior Tibial Absorbents.

The anterior tibial artery is generally attended by one which comes with it from the sole, and by another which commences on the upper surface of the foot. The first mentioned absorbent continues with the artery. The last often passes through an aperture in the interosseal ligament, about one-third of the distance from the ankle to the knee, and accompanies the fibular artery, while the anterior tibial artery is joined by other absorbents about the same place. In some instances a small absorbent gland occurs in this course at a short distance below the knee.

The Posterior Tibial Absorbents

Have been injected from the under side of the toes. They accompany the ramifications on the sole of the foot; and, after uniting, continue with the main trunk up the leg, where they enter the popliteal glands.

The *Peroneal Absorbents* arise also from the sole of the foot, and its external side. They accompany the peroneal artery, and terminate in the popliteal glands, which receive also the absorbents from the knee and ham.

From these glands four or five absorbent vessels proceed which accompany the great blood-vessels of the lower extremity; and, proceeding with them through the aperture in the tendon of the adductors, continue upwards until they enter some of the glands of the groin.

The glands of the ham and groin, which are so intimately connected with the absorbents of the lower extremity, are very different from each other.

The *Popliteal Glands*, or those of the *Ham*, are but three or four in number, and very small in size. They are generally deep-seated, and very near the artery.

The *Inguinal Glands* vary in number from eight to twelve or more. They are superficial and deep-seated. The *superficial* communicate principally with the superficial absorbents. The lowermost of them are at some distance below Poupart's ligament, and the uppermost are rather above it. They are exterior to the fascia of the thigh. Their number is generally six or eight, while that of the deep-seated is but three or four.

The superficial absorbents from below, approach very near to each other, and enter these glands. They are commonly distributed among three or four of the lowermost; but some of them pass by these, and proceed to one that is higher up; and sometimes there are absorbent vessels which pass to the abdomen without entering into any of the glands of the groin.

The *deep-seated* absorbents pass into the deep-seated glands, which, as has been already observed, are but few, and lie very near the artery, under the fascia of the thigh. The two sets of glands are connected with each other by many absorbent vessels that pass between them. The vessels which finally go out of these glands are considerably less in number than those which enter into them. They proceed under Poupart's ligament, and, in some instances, a large proportion of them passes through three glands which lie below this ligament, and are often so arranged, that they lie on each side of the great femoral vessels, and above them. One very frequently is found on the inside of the femoral vein, in the vacuity between it and the internal part of the ligament. All the absorbents of the lower extremity, however, do not enter these glands. Some pass along the great vessels and enter other glands near the margin of the pelvis. Some, also, descend a short distance into the pelvis, and unite with vessels that are passing from the pelvis to the plexus and the glands that surround the external iliac.

The absorbents which proceed from the glands last mentioned, joined to those which pass under Poupart's ligament without entering these glands, and some which come from the pelvis,

form a large plexus, which almost surrounds the external iliac vessels, and contains many glands.

These *External Iliac Glands* vary in their number from six to ten or twelve. They lie on the side of the pelvis, in the course of the external iliac vessels, and some of them are of considerable size. These glands and the plexus of absorbents, extend in the track of the iliac vessels, to the first lumbar vertebra. In this course they are joined by the plexus which comes from the pelvis; and soon after they arrive at the *Lumbar Glands*, which form a very large assemblage, that extends from the bifurcation of the aorta to the crura of the diaphragm.

These glands lie irregularly on the aorta, the vena cava, and the lumbar vertebræ. Most, if not all, the absorbents above mentioned pass through some of them; and from the union of these absorbents, some of the great branches, which unite to form the thoracic duct, are derived.

In this course, from the thigh to the lumbar glands, these absorbent vessels are joined by several others. The *Superficial Absorbents* of the scrotum commonly enter into the upper inguinal glands, and thus unite to the great body of absorbents.

The *Absorbents of the Testicles*, originate in the body, and the coats of the testicle, and in the epididymis, and are remarkably large and numerous. They proceed along the spermatic cord, through the abdominal ring, to the lumbar glands. These vessels are remarkable for the little communication they have with each other.

The *Deep-seated Absorbents of the Scrotum* accompany the absorbents of the testicle to the lumbar glands; but those which are superficial enter the upper inguinal glands.

The *Absorbents of the Penis* are also deep-seated and superficial. The deep-seated arise from the body of the penis, and accompany the internal pudic artery into the pelvis. The superficial absorbents arise from the prepuce, and pass along the dorsum of the penis. (See Fig. 73, p. 311.) There are frequently several trunks which receive branches from the lower surface of the penis in their course. At the root of the penis they generally separate to the right and left, and pass to the glands on the respective sides.

In females, the absorbents of the interior of the clitoris accompany the internal pudic artery. Some, which arise about the vagina, pass through the abdominal ring with the round ligament; and others proceed to the inguinal glands.

Of the Absorbents of the Abdomen and Thorax.

The Absorbents of the lower portions of the parietes of the Abdomen and Pelvis unite into trunks that follow the epigastric, the circumflex and the iliac, as well as the lumbar and sacral arteries, &c. They proceed to some of the glands which are in the groin; or in the external iliac, the hypogastric, or some of the contiguous plexuses.

The Absorbents of the Womb are extremely numerous; and, in the gravid state, are very large. Those which are on the neck and anterior part of the body accompany the spermatic vessels.

The Absorbents of the Bladder pass to small glands on its lateral and inferior parts, and finally join the hypogastric plexus.

The Absorbents of the Rectum are of considerable size. They pass through glands that lie upon that intestine, and unite with the lumbar plexus.

The Absorbents of the Kidney are superficial and deep-seated. They are very numerous, but, in a healthy state of the parts, are discovered with difficulty. Cruikshank describes them as they appeared, filled with blood, in consequence of pressing upon the kidney when its veins were full of blood. Mascagni did not inject the superficial vessels with mercury; but describes them as they appeared when filled with colourless size, after he had injected the blood-vessels of the organ with the coloured fluid. The deep-seated absorbents pass out of the fissure of the kidney with the blood-vessels, and unite with the superficial; they proceed to the lumbar plexus, and pass into different glands.

Absorbent vessels can be proved to proceed from the pelvis of the kidney, and the ureters, by orifices analogous to those above mentioned.

The Glandulæ Renales are also supplied with absorbents, which are numerous in proportion to the size of the organs. They commonly join those of the kidney.

The Absorbents of the Intestines

Have generally been called *Lacteals*, from the white colour of the chyle which they contain: but there seems no reason for believing that they are different in their structure and nature from the absorbents in other parts of the body. A small number of them appear as if they formed a part of the structure of the intestines, and originated from their external surface, as they do in other parts of the abdomen; while the principal part of them are appropriated to the absorption of the contents of the cavity of the intestines.

The first mentioned absorbents run between the muscular and peritoneal coats, and proceed for some distance lengthways on the intestine, while the others proceed for some distance within the muscular coat, with the arteries; and, after passing through it, continue between the lamina of the mesentery.

Branches of these different absorbents are frequently united in one trunk, so as to prove that there is no essential difference between them.

The absorbents which come from the internal surface of the intestines commence in the villi. The manner in which they originate has been the subject of considerable inquiry, as has been stated in the account of the intestines.*

The lacteals or absorbents of the intestines are very numerous. They pass between the lamina of the mesentery to *glands* which are also seated between those lamina. The number of these glands is very considerable,† and they are various in size—some being very minute, and others eight or ten lines in diameter. They are generally placed at a small distance from each other, and are most numerous in that part of the mesentery which is nearest to the spine. They are almost always at some distance from the intestines. They appear to be precisely like the absorbent glands in other places.

These absorbent vessels, in their course frequently divide into branches; which sometimes go to the same gland, sometimes to different glands, and sometimes unite with other absorbent ves-

* See page 42.

† They have been estimated between 130 and 150.

sels. As they proceed, they frequently enlarge in size. When they have arrived near the spine, they frequently form three or four trunks, and sometimes one or two; which proceed in the course of the superior mesenteric artery, until they have arrived near to the aorta. Here they either pass into the thoracic duct, or descend and join the trunks from the inferior extremities, to form the thoracic duct. The absorbents of the great intestines are not equal in size to those of the small; but they are numerous. They enter into glands, which are very near, and in some places in contact with the intestine; and are commonly very small in size. The vessels which arise from the cæcum, and the right portion, as well as the arch of the colon, unite with those of the small intestines; while the vessels from the left side of the colon, and the rectum, proceed to the lumbar glands.

The absorbents of the intestines are frequently injected with mercury; but the injection does not proceed to their termination with so much facility as it does in other vessels of the same kind. They have, however, very often been seen in animals who were killed for the purpose after eating milk; and in several human subjects who died suddenly during digestion. The description of the origin of the lacteals, quoted in page 45, from Mr. Cruikshank, was taken from a subject of this kind, of which an account is given in his work on the absorbent vessels, p. 59.

It is worthy of note, that in several instances, in which the lacteals were thus found distended with chyle, the glands in the mesentery were also uniformly white.

The Absorbents of the Stomach

Are of considerable size, and form three divisions. The vessels of the first set appear upon both sides of the stomach, and pass through a few glands on the small curvature near the omentum minus. From these glands they proceed to others, which are larger, and which also receive some of the deep-seated absorbents of the liver. The vessels from these glands pass to the thoracic duct, near the origin of the cœliac artery. The second arise also on both sides of the stomach, and pass to the left extremity of the great curvature to unite with the absorbents of

that side of the great omentum. They then proceed to the lymphatics of the spleen and pancreas, to the thoracic duct. The last set, pass off from the right extremity of the great curvature, and unite also with absorbents from the right portion of the omentum. They proceed near the pylorus, and go to the thoracic duct, with some of the deep-seated absorbents of the liver.

Although the absorbents of the stomach are deep-seated, as well as superficial, it is a general sentiment, that they do not contain chyle in the human subject; notwithstanding chyle has been found in the absorbents on the stomach of dogs, and some other animals. It ought, however, to be remembered, that Sabatier has, in some instances, seen white lines on the stomach, which he supposed to be lacteals.

The Absorbents of the Liver

Are especially interesting, because they have been more completely injected than those of any other viscus. They are *deep-seated* and *superficial.* The superficial, it has been already observed, admit of injection in a retrograde direction, and, therefore can be exhibited most minutely ramified. They communicate freely with each other, and also with the deep-seated vessels, *by their small ramifications;* so that the whole gland has been injected from one large vessel.

The gland is so large, that the absorbents of the superior and inferior surfaces proceed from it in different directions.

A large absorbent is generally found on the suspensory ligament. This is formed by the union of a great many branches that arise both on the right and left lobes, but principally on the right. It often passes through the diaphragm at an interstice which is anterior to the xiphoid cartilage, and then proceeds through the glands on the anterior part of the pericardium.

Several absorbents proceed to the lateral ligaments on each side, and then pass through the diaphragm. Some of these branches return again into the abdomen, and the others generally run forwards in the course of the ribs, and join those which pass up from the suspensory ligament. The trunk, or trunks, formed by these vessels, either pass up between the lamina of the medi-

astinum, and terminate in the upper part of the thoracic duct; or they accompany the internal mammary arteries, and terminate on the left side in the thoracic duct, and on the right in the trunk of the absorbents of that side.

The *Absorbents on the concave side of the liver* are as numerous as those on the convex side; they are also very abundant on the surface of the gall-bladder. The greatest part of them join the deep-seated vessels.

The *Deep-seated Absorbents* proceed in considerable numbers from the interior of the liver through the portæ. They accompany the biliary ducts and the great blood-vessels of the organ; and, after passing through several glands, near the vena portarum, terminate in the thoracic duct, near the commencement of the superior mesenteric artery.

Mascagni states, that the absorbents of the liver will be distended, by injecting warm water into the biliary ducts, or the vena portarum.

He also observes, that in those preparations in which the superficial vessels are completely injected, in the retrograde direction, the peritoneal coat of the liver appears to be composed entirely of absorbent vessels; and to be connected to the membrane within, by many filaments, which are also absorbent vessels.

The Absorbents of the Spleen

Are composed of superficial and deep-seated vessels; but they differ greatly from those of the liver, in this respect, that the *superficial vessels* are remarkably small in the human subject.

Mascagni, however, asserts, that when the blood-vessels of the spleen are injected with size, coloured with vermilion, these absorbents will be filled with colourless size.

In the spleen of the calf the superficial absorbents, are remarkably large.

In the human subject the superficial absorbents of the spleen proceed from the convex to the concave surface, and there communicate with the deep-seated absorbents, which proceed from the interior of the organ with the blood-vessels.

These *Deep-seated Absorbents* are very numerous, and also large. They accompany the splenic artery; and in their course pass through many glands, some of which are said to be of a dark colour. The glands lie on the splenic artery, at a short distance from each other. The absorbents of the spleen receive the absorbents of the pancreas in their course; they unite with the absorbents of the stomach and the lower surface of the liver, and pass with them to the thoracic duct.

Little has been latterly said by practical anatomists respecting

The Absorbents of the Pancreas.

Mr. Cruikshank once injected them in the retrograde direction; he found that they came out of the lobes of the pancreas in short branches like the blood-vessels, and passed at right angles into the absorbents of the spleen, as they accompanied the artery in the groove of the pancreas.

*The Thoracic Duct,**

Or common trunk of the absorbent system, is formed by the union of those absorbent vessels which are collected on the lumbar vertebræ.

These vessels, as it has been already observed, are derived from various sources, viz.

The lower extremities; the lower part of the trunk of the body; the organs of generation; the intestines, with the other viscera of the abdomen and pelvis, except a part of the liver. Their number is proportioned to the extent of their origin: for, with the numerous glands appropriated to them, they form the largest absorbent plexus in the body, and are spread over a considerable portion of the aorta and the vena cava.

The manner in which these vessels unite to form the thoracic duct, is very different in different subjects; but in a majority of cases it originates immediately from three vessels, two of which are the trunks of the absorbents of the lower extremities, and

* First discovered by Eustachius, in the horse, 1564; but he considered it a vein for the nourishment of the thoracic viscera.—H.

the other is the common trunk of the lacteals and the other absorbents of the intestines.

These vessels generally unite on the second or third lumbar vertebræ; and, in some instances, the trunk which they form dilates considerably, soon after its commencement; in consequence of which it was formerly called the *receptacle of the chyle.* At first it lies behind the aorta, but it soon inclines to the right of it, so as to be behind the right crus of the diaphragm. In the thorax, it appears on the front of the spine, between the aorta and the vena azygos, and continues between these vessels until it has arrived at the fourth or third dorsal vertebra. It then inclines to the left, and proceeds in that direction until it emerges from the thorax, and has arisen above the left pleura, when it continues to ascend behind the internal jugular, nearly as high as the sixth cervical vertebra: it then turns downward and forward, and after descending from six to ten lines, terminates in the back part of the angle formed by the union of the left internal jugular with the left subclavian vein. Sometimes, after rising out of the thorax, it divides into two branches, which unite before they terminate. Sometimes it divides, and one of the branches terminates at the above mentioned angle, and the other in the subclavian vein, to the left of it.

The orifice of the thoracic duct has two valves, which effectually prevent the passage of blood into it from the vena cava.

There are sometimes slight flexures in the course of the duct; but it generally inclines to the left, in the upper part of the thorax, as above mentioned; and is then so near the left lamen of the mediastinum that, if it be filled with coloured injection, it can be seen through that membrane, when the left lung is raised up and pressed to the right.

The duct sometimes varies considerably in its diameter in different parts of its course. About the middle of the thorax it has often been found very small. In these cases it generally enlarges in its progress upwards, and is often three lines in diameter, in its upper part. Many anatomists have observed it to divide and to unite again, about the middle of the thorax.

The Absorbents of the Lungs.

The absorbents of the lungs are very numerous, and, like those of other viscera, are superficial and deep-seated.

The large superficial vessels run in the interstices between the lobuli, and, therefore, form angular figures of considerable size. In successful injections, the vacancies within these figures are filled up with small vessels, and the whole surface appears minutely injected.

Mascagni observes, that the superficial vessels are very visible when any fluid has been effused into the cavity of the thorax; or when warm water is injected, either into the blood-vessels of the lungs, or the ramifications of the trachea. Cruikshank demonstrated them by inflating the lungs of a still-born child; in which case the air passes rapidly into them.

The deep-seated absorbents accompany the blood-vessels and the ramifications of the bronchiæ. They pass to the dark-coloured glands, which are situated on the trachea at its bifurcation; and on those portions of the bronchiæ which are exterior to the lungs. The injection of the absorbents, which pass to and from these glands, seem to prove that they are of the same nature with the absorbent glands in general, notwithstanding their colour. They are numerous; and they vary in size, from a diameter of two lines to that of eight or ten.

From these glands, *some of the absorbents of the left lung* pass into the thoracic duct, while it is in the thorax, behind the bifurcation of the trachea; others proceed upwards and enter into it near its termination; while those of the right lung terminate in the common trunk of the absorbents of the right side.

CHAPTER XI.

OF THE ABSORBENTS OF THE HEAD AND NECK; OF THE UPPER EXTREMITIES, AND THE UPPER PART OF THE TRUNK OF THE BODY.

The absorbents from the various parts of the head pass through glands, which are situated on the neck or the lower part of the head. Those on the head are the least numerous, and also the least in size. Some of them, which are generally small, lie about the parotid gland. Several of them, which are also small, are on the occiput, below and behind the mastoid process. Sometimes there are two or three on the cheek, near the basis of the lower jaw, about the anterior edge of the masseter muscle. Below the lower jaw, in contact with the sub-maxillary gland and anterior to it, there are always a number of these glands, which are generally small, but often swelled during infancy.

The Glands on the Neck are the most numerous. Many of them are within the sterno-mastoid muscle, and accompany the internal jugular vein and the carotid artery down to the first rib. Many also lie in the triangular space between the sterno-mastoid muscle, the trapezius, and the clavicle; therefore it has been truly said that the glands of the neck are more numerous than those of any other part except the mesentery. They are frequently called *Glandulæ Concatenatæ.* It has already been mentioned that the various absorbents, which are connected with these glands, unite on each side into a trunk, which on the left passes into the thoracic duct, and on the right into the common trunk of the absorbents of that side.

Of the Absorbents of the Head and Neck.

There is the greatest reason to believe that the brain and its appendages are supplied with absorbents like the other parts. Some of these vessels have been discovered in the cavity of the

cranium; but very little precise information has as yet been obtained, respecting the extent, or arrangement of the absorbent system, in this part of the body.

The absorbents on the exterior of the head are as numerous as in other parts of the body. On the occiput they pass down, inclining towards the ear, and continue behind it to the side of the neck; behind the ear they pass through several glands. From the middle or temporal region of the cranium, they pass with the carotid artery before the ear, and enter some small glands that lie on the parotid; from which they continue to the neck.

They are on every part of the face, and unite, so that their principal trunks, which are very numerous, pass over the basis of the lower jaw, near the facial artery. They enter into glands, which are also very numerous, immediately under the jaw, or which are sometimes to be found on the cheek, at the anterior edge of the masseter muscle. All the absorbents of the exterior part of the head pass to the glands on the side of the neck, already described.

Those from the interior of the nose accompany the ramifications of the internal maxillary artery, and proceed to glands behind the angle of the lower jaw; into which glands also enter the absorbents of the tongue and inner parts of the mouth.

The absorbents of the thyroid gland, on the left side, pass down to the thoracic duct; those on the right, unite to the trunk of the absorbents on that side, near its termination. It has been remarked, that they can be readily injected, by thrusting the pipe into the substance of the gland.

Of the Absorbents of the Arm and Upper Part of the Trunk.

The absorbents of the arm are superficial and deep-seated, like those of the lower extremity.

The *superficial absorbents* have been injected on the anterior and posterior surfaces of the fingers and the thumb, near their sides. On the back of the hand they are very numerous, and increase considerably in their progress up the fore-arm. As they proceed upwards, they incline towards the anterior surface of the fore-arm; so that by the time they have arrived at the

elbow, almost all of them are on the anterior surface. The absorbents on the anterior part of the hand are not so numerous as those on the back. Sometimes there are digital branches from the fingers, and an arcus in the palm; but this bow is not formed by one large absorbent, analogous to the ulnar artery. On the contrary, its two extremities are continued over the wrist, and pass on the fore-arm like the absorbents.

At the elbow some of them often pass into one or two small glands, which are very superficial; but the whole of the absorbents, somewhat reduced in number, as some of them unite together, pass along with the blood-vessels into the hollow of the arm-pit, where they enter the axillary glands. There are generally one or more vessels which pass in the course of the cephalic vein, between the pectoral and the deltoid muscle, and enter into some of the glands under the clavicle.

There are almost always several glands in and near the axilla. Some of them are very near the great blood-vessels; sometimes one or more of them are much lower; sometimes they are to be found under the pectoral muscle. They are commonly not so large as those of the groin, and are surrounded with fat.

The deep-seated absorbents originate also at the fingers, and soon accompany the branches of the arteries. Those which attend the radial artery, originate on the back of the hand, and also in the palm, where they are associated with the arcus profundus. They go up with the radial artery to the elbow, and sometimes pass through a small gland about the middle of the fore-arm.

Those which attend the ulnar artery, commence under the aponeurosis palmaris, and go with the artery to the elbow; at the bend of the elbow they are generally joined by one or more, which accompany the interosseal artery; there they unite, so as to form several trunks, which pass up to the axilla with the humeral artery. They sometimes pass through one or two glands, which are near the elbow; and they receive in their course, deep-seated branches from the muscles on the humerus.

The absorbents from the anterior and external part of the thorax, and the upper part of the abdomen, also proceed to the

axilla, and enter into the glands there; those which are deep-seated joining the deep-seated vessels. The absorbents of the mammæ pass to the same glands; and when they are affected with the virus of cancer, can often be perceived, in their course, in the living subject.

The absorbents of the uppermost half of the back, and those of the back of the neck, go likewise to the axilla.

The absorbent vessels, collected from these various sources, proceed from the exterior to the innermost glands, but with a considerable diminution of their number: they accompany the subclavian vein, and are reduced to one or two trunks, that generally unite before their termination. On the *left side*, the absorbents of the head and neck generally open into the thoracic duct, as has been already observed; and those of the left arm also open into the thoracic duct, or into the subclavian vein very near it. On the *right side* the absorbents from each of these parts empty into the common trunk, which often is formed by the union of large vessels, from four sources, and called *brachio-cephalic;* namely, the head, the thyroid gland, the right arm, and the right cavity of the thorax, &c. The diameter of the trunk is very considerable; but it is often not more than half an inch in length. It generally opens into the right subclavian vein, at the place where it unites to the right internal jugular.

Two respectable physiologists of Europe, (M. Seguin, of Paris, and the late Dr. Currie of Liverpool,) have doubted whether absorption takes place on the external surface of the skin.* This question has been examined in a very interesting manner by several graduates of the University of Pennsylvania, who chose it for the subject of their inaugural theses; namely, Drs. Rousseau, Klapp, Daingerfield, Mussey, and J. Bradner Stewart.

The three first of these gentlemen state that when spirit of turpentine, and several other substances which are commonly supposed to be absorbed by the skin, were applied to it in a way which prevented their volatile parts

* I believe that M. Seguin's Memoir on this subject was read to the Academy of Sciences a short time before the meetings of that body were suspended. It was published by M. Fourcroy, in La Medicine Eclairée par les Sciences Physiques, vol. iii. An extract from M. Fourcroy's publication may be seen in the 19th chapter of the first volume of Dr. Currie's "Medical Reports on the Effects of Water," &c. in which is also contained a statement of the Doctor's own experiments and reflections.

from entering the lungs by respiration, no absorption took place. But when the inspired air was impregnated with exhalations from these substances, they perceived satisfactory proofs that the exhalations entered the system. From these facts they inferred that when those articles entered the body by absorption, they were taken in by the lungs, and not by the external surface.

On the other hand, the two gentlemen last mentioned, state that after immersing themselves in a bath consisting of a decoction of rhubarb, of madder, or of turmeric, their urine became tinged with these substances. They also assert that the colouring matter of these different articles is not volatile; and, therefore, could not have entered the lungs during the experiments.*

The statement in page 304, from Dr. Sömmering, that when mercury is injected backwards in the absorbent vessels which originate on the foot, it will sometimes appear in small globules on the skin of the foot, has an important connexion with this subject.†

About the middle of the last century, it was generally believed by anatomists that absorption was performed by the veins. This doctrine seemed to be established by the experiments of Kaaw Boerhaave, which are related with many other interesting statements, in his work, entitled "Perspiratio Dicta Hippocrati," &c. published at Leyden, in 1738. In these experiments it appeared to the author, that when the stomach of a dog was emptied of its contents, and filled with warm water, immediately after death, the water passed into the minute ramifications of the veins of the stomach, and from them to the vena portarum, and ultimately to the heart in large quantities.

This account appears to be disproved by some experiments of the late John Hunter, made about twenty years after, and published in the Medical Commentaries of Dr. William Hunter, part I.—Mr. Hunter's experiments have been considered as establishing the fact, that absorption, (in the intestines at least,) is performed exclusively by the lacteals, or proper absorbent vessels, and not at all by the veins. Kaaw Boerhaave is of

* The Thesis of Dr. Rousseau was published in 1800. Those of Drs. Klapp and Daingerfield in 1805. Dr. Mussey published in the Third Supplement to the Medical and Physical Journal of Dr. Barton, in 1809. Dr. Stewart published in 1810. Additional Observations by Drs. Klapp, Rousseau and Smith, are published in the Philadelphia Medical Museum, vol. i. new series.

† Since the publication of the first volume, the author has enjoyed the advantage of consulting a translation, in manuscript, of some parts of the German edition of Dr. Sömmering's valuable work on the Structure of the Human Body.

course supposed to have been mistaken; and Mascagni, who has repeated his experiments, refers the appearance of water in the veins to transudations through the coats of the intestines; which he has observed to take place in a great degree.

In the year 1809, a memoir was presented to the national institute of France by Messrs. Magendie and Delile, which contains an account of some experiments that have an important relation to the above mentioned subject.*—The authors being greatly surprised at the rapidity with which the poison of Java, &c. appeared to enter the sanguiferous system, instituted a series of experiments to determine whether these substances proceeded to that system by the circuitous route of the absorbent vessels, or by the shorter course of the veins. Two of their experiments are especially interesting. They made an incision through the parietes of the abdomen of a living dog, who had eaten a large quantity of meat some hours before, (that his lacteals might be visible from their distention with chyle,) and drawing out a portion of the small intestine, they applied two ligatures to it, at the distance of five inches from each other. The portion of intestine between these ligatures was then separated by incision from the rest of the intestinal tube, and all the lacteals and blood-vessels, &c. which passed to and from it, were divided, except one artery and a vein. A considerable length of this artery and vein were detached from all the surrounding parts, so that the authors supposed these vessels to form the only connexion between the portion of the intestine, and the rest of the body. Into the cavity of the intestine, which was thus circumstanced, they introduced a small quantity of the poison, and, to their astonishment, it produced its fatal effects in the same manner it would have done if it had been introduced into the intestine while all its connexions with the body were entire. This experiment, they assert, was repeated several times, without any difference in the result.

After several other experiments, they finally separated the thigh from the body of a living dog in such a manner that the crural artery and vein were left undivided. A quill was then introduced into the artery, and two ligatures were applied to fix it round the quill. The artery was then divided between the two ligatures. The vein was managed in the same manner. There was, therefore, no communication between the limb and the body, except by the blood which passed through the divided vessels and the quills. The poison was then introduced under the skin of the foot, and soon occasioned the death of the animal; its deleterious effects commencing about four minutes after its application to the foot. This

* The title of the paper is a "Memoir on the Organs of Absorption in Mammiferous Animals." A translation of it was published in the Medical and Philosophical Register of New York, and in several other periodical works.

experiment appears to prove decidedly that the blood is the vehicle by which poison, when applied to the extremities, is carried to the body; although it may not determine the question whether this poison was taken up by the absorbents or by the veins.*

Some other experiments made by the authors gave results, which are very difficult indeed to explain. They wished to know if the blood of an animal thus contaminated, would produce similar effects upon another animal; and, with a view to ascertain this point, they insinuated a small piece of wood, covered with the poison, into the thick part of the left side of the nose of a dog. Three minutes after the introduction of the poison, they transfused blood from the jugular vein of the same side, into one of the veins of another dog. About one minute after the commencement of the transfusion, the effects of the poison began in the dog to which it was applied, and continued until his death. Transfusion into the veins of the other dog went on during the whole time, and he received a large quantity of blood from the dying dog, without producing any effect. They varied this experiment in the following manner. The thigh of a dog was separated from the body; the artery and the vein were arranged as in the former experiment; and poison was introduced into the foot. Three minutes after the introduction of the poison the blood of the crural vein was passed into the jugular vein of another animal and transfusion was continued five minutes without producing any effect upon the animal receiving the blood; it was then stopped, and the crural vein was so arranged that the blood flowed from it into the animal to which it belonged. This animal very soon exhibited symptoms of the operation of the poison.†

From these very interesting experiments the authors infer that "*foreign matters do not always proceed through the Lymphatic or Absorbent Vessels, when they enter into the Sanguiferous system.*"

* This experiment has been repeated in Philadelphia. See Professor Chapman's Medical and Physical Journal for February, 1823, No. 10.—H.

† An account of these experiments was published by M. Magendie in a pamphlet. A statement of them is also contained in the report made to the Institute by the committee to whom the memoir was referred, which is published in the Journal de Physique, for March, 1813. In that statement this last mentioned experiment is omitted.

A most interesting series of inquiries and experiments in regard to the laws of absorption will be found in Professor Chapman's Journal of the Medical and Physical Sciences, No. 6, in a report of a Committee of the Academy of Medicine, signed by Doctors Lawrence and Coates, of this city. And a continuation of the same will be found in No. 10 of the same Journal, signed by Doctors Lawrence and Coates. Since the publication of the latter, to the regret of all who knew him, and to the great loss of Anatomy and of Physiology, the indefatigable and excellent Lawrence is no more.—H.

This memoir was referred by the Institute to four of its members, who are particularly distinguished by their profound knowledge of anatomy and physiology. These gentlemen, after stating their belief that the functions of the lymphatic or absorbent system have been completely ascertained by the experiments and observations of Hunter, Cruikshank, Mascagni, &c. say farther, that in their opinion, the above mentioned inference ought to be a little modified, and that facts are not sufficiently numerous, or applicable to the point in question, to justify the inference that *foreign matters do not always proceed through the Lymphatic or Absorbent Vessels, when they enter the Sanguiferous system.* But they also add, that as the author is still engaged in a series of experiments on the subject, they will suspend their judgment respecting the inferences to be deduced from the present statement.

The most extensive account of the absorbent system is contained in the "Historia et Ichnographia Vasorum Lymphaticorum Corporis Humani" of Mascagni,—"The Anatomy of the Absorbing Vessels of the Human Body, by W. Cruikshank;"—and "The Description of the Lymphatic System, by William Hewson," (the second volume of his Experimental Inquiries,) are also very interesting publications.

EXPLANATION OF PLATE IX.

Fig. 1. Exhibits the more superficial Lymphatic Vessels of the Lower Extremity.

A, The spine of the os ilium. B, The os pubis. c, The iliac artery. D, The Knee. E, E, F, Branches of the crural artery. G, The musculus gastrocnemius. H, The tibia. I, The tendon of the musculus tibialis anticus. On the outlines, a, A lymphatic vessel belonging to the top of the foot. b, Its first division into branches. c, c, c, Other divisions of the same lymphatic vessel. d, A small lymphatic gland. e, The lymphatic vessels which lie between the skin and the muscles of the thigh. f f, Two lymphatic glands at the upper part of the thigh, below the groin. g g, Other glands. h, A lymphatic vessel which passes by the side of those glands without communicating with them, and bending towards the inside of the groin at (i), opens into the lympatic gland (k). 11, Lymphatic glands in the groin, which are common to the lymphatic vessels of the genitals and those of the lower extremity. m, n. A plexus of lymphatic vessels passing on the inside of the iliac artery.

Fig. 2. Exhibits a back view of the Lower Extremity, dissected so as to show the deeper seated Lymphatic Vessels which accompany the Arteries.

A, The os pubis. B, The tuberosity of the ischium. C, That part of the os ilium which was articulated with the os sacrum. D, The extremity of the iliac artery appearing above the groin. E, The knee. F F, The two cut surfaces of the triceps muscle, which was divided to show the lymphatic vessels that pass through its perforation along with the crural artery. G, The edge of the musculus gracilis. H, The gastrocnemius and soleus much shrunk by being dried, and by the soleus being separated from the tibia to expose the vessels. I, The heel. K, The sole of the foot. L. The superficial lymphatic vessels passing over the knee, to get to the thigh. On the outlines: M, the posterior tibial artery. a, A lymphatic vessel accompanying the posterior tibial artery. b, The same vessel crossing the artery. c, A small lymphatic gland, through which this deep-seated lymphatic vessel passes. d, The lymphatic vessel passing under a small part of the soleus, which is left attached to the bone, the rest being removed. e, The lymphatic vessel crossing the popliteal artery. f, g, h, Lymphatic glands in the ham, through which the lymphatic vessel passes. i, The lymphatic vessel passing with the crural artery, through the perforation of the triceps muscle. k, The lymphatic vessel, after it has passed the perforation of the triceps, dividing into branches, which embrace the artery (l). m, A lymphatic gland belonging to the deep-seated lymphatic vessel. At this place those vessels pass to the fore part of the groin, where they communicate with the superficial lymphatic vessel. n, A part of the superficial lymphatic vessel appearing on the brim of the pelvis.

ANATOMY

Plate IX

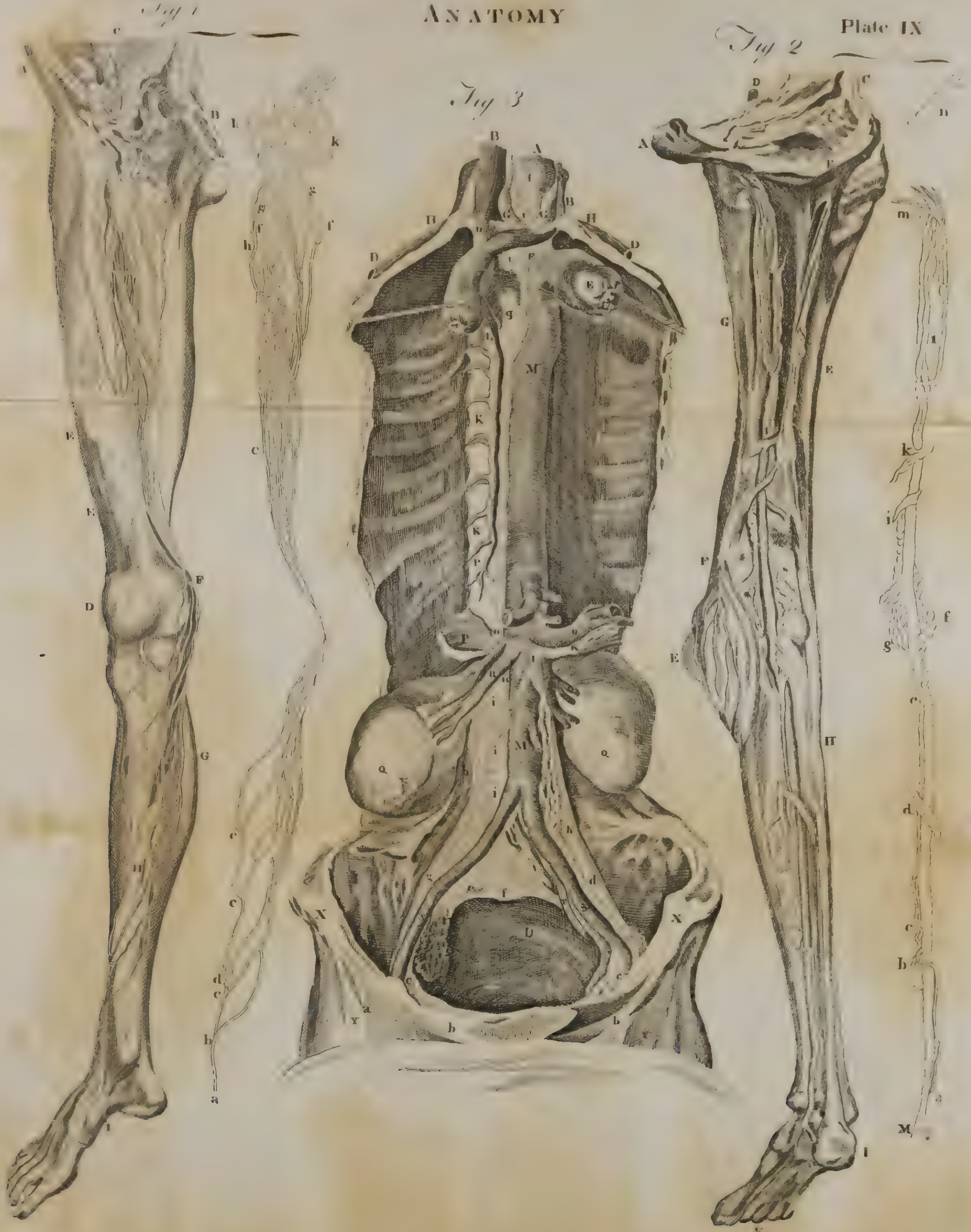


Fig. 3. Exhibits the Trunk of the Human Subject prepared to show the Lymphatic Vessels and the Ductus Thoracicus.

A, The neck. B B, The two jugular veins. C, The vena cava superior. D D D D, The subclavian veins. E, The beginning of the aorta, pulled to the left side by means of a ligature, in order to show the thoracic duct behind it. F, The branches arising from the curvature of the aorta. G G, The two carotid arteries. H H, The first ribs. I I, The trachea. K K, The spine. L L, The vena azygos. M M, The descending aorta. N, The cœliac artery, dividing into three branches. O, The superior mesenteric artery. P, The right crus diaphragmatis. Q Q, The two kidneys. R, The right emulgent artery. S S, The external iliac arteries. g, d, The psoas muscles. T, The internal iliac artery. U, The cavity of the pelvis. X X, The spine of the os ilium. Y Y, The groins. a, A lymphatic gland in the groin, into which lymphatic vessels from the lower extremity are seen to enter. b b, The lymphatic vessels of the lower extremities passing under Poupart's ligament. cc, A plexus of the lymphatic vessels lying on each side of the vessel. d, The psoas muscle with lymphatic vessels lying upon its inside. e, A plexus of the lymphatics, which have passed over the brim of the pelvis at (c), having entered the cavity of the pelvis, and received the lymphatic vessels belonging to the viscera contained in that cavity, next ascends and passes behind the iliac artery to (g). f, Some lymphatic vessels of the left side passing over the upper part of the os sacrum, to meet those of the right side. g, The right psoas, with a large plexus of lymphatics lying on its inside. h h, The plexus lying on each side of the spine. i i i, Spaces occupied by the lymphatic glands. k, The trunk of the lacteals lying on the under side of the superior mesenteric artery. l, The same dividing into two branches, one of which passes on each side of the aorta: that of the right side being seen to enter the thoracic duct at (*m*). *m*, The thoracic duct, beginning from the large lymphatics. *n*, The duct passing under the lower part of the crus diaphragmatis, and under the right emulgent artery. *o*, The thoracic duct penetrating the thorax. *p*, Some lymphatic vessels joining that duct in the thorax. *q*, The thoracic duct passing under the curvature of the aorta to get to the left subclavian vein—the aorta being drawn aside to show the duct. *r*, A plexus of lymphatic vessels passing upon the trachea from the thyroid gland to the thoracic duct.

PART X.

OF THE BRAIN AND SPINAL MARROW: OF THE EYE AND THE EAR.

CHAPTER XII.

OF THE BRAIN.

The whole of the soft mass, which fills the cavity of the cranium, is called the brain. This mass is covered by three membranes: two of which were called *meninges* or *matres*, by the ancient anatomists: who believed that all the other membranes of the body originated from them.

These membranes are denominated the *Dura Mater*, *Tunica Arachnoidea*, and *Pia Mater*.

Of the Membranes of the Brain, and Sinuses of the Dura Mater.

The *Dura Mater* encloses the brain and all its appendages, and lines the different parts of the cranium. It consists of one membrane of a very dense texture, which in several places is composed of two or more lamina. It is the thickest and strongest membrane of the body, and is composed of tendinous fibres, which have a shining appearance, particularly on its inner surface. In many parts these fibres run in a variety of directions, and decussate each other at different angles.

The dura mater adheres every where to the surface of the cranium, in the same manner as the periosteum adheres to the bones in the other parts of the body; but is more firmly connected at the sutures and foramina than elsewhere; and so much more firmly in children than in adults, that in separating it from

the cranium, it is apt to bring along with it some of the fibres of the bone to which it is attached. In the adult, the separation of the bone from the membrane is less difficult, in consequence of many of the fibres being obliterated; although in old age the adhesion is sometimes very strong.

The inner surface of the dura mater, which is remarkably smooth, is in close contact with the brain, but adheres only where the veins go into the sinuses; and is lubricated by a fluid discharged through its vessels, which guards the brain from danger, according as it may be affected by the different states of respiration.

The dura mater serves as a defence to the brain, and supplies the place of a periosteum to the inside of the cranium; giving nourishment to it, as is evident from the numerous drops of blood which appear after removing a portion of it.

The *proper* blood-vessels of the dura mater are not very numerous. Its arteries are derived partly from the external carotids, and partly from the internal carotids and the vertebral arteries. Corresponding veins accompany these arteries; but the dura mater forms also reservoirs, that contain the venous blood, which is brought from the substance of the brain. These are called sinuses, and are very different from common veins.

Nerves have been traced into the dura mater by the French anatomists, derived from the sympathetic in the neck. There have been disputes respecting its sensibility; but there is reason to believe that in a sound state it has very little.

The *Tunica Arachnoidea* is an exceedingly thin, tender, and transparent membrane, in which no vessels have been hitherto observed.

It is spread uniformly over the surface of the brain, enclosing all its convolutions, without insinuating itself between any of them.

At the upper part of the brain it adheres so closely to the subjacent coat by fine cellular substance, that it can scarcely be separated from it; but in different parts of the base of the brain, particularly about the tuber annulare and medulla oblongata, it

is merely in contact with the membrane under it, and may readily be raised from it by the assistance of the blow-pipe.

The *Pia Mater*, named from its tenderness, is somewhat of the nature of the former covering, but is extremely vascular.

It covers the brain in general, enters double between all its convolutions, and lines the different cavities called *ventricles*.

It serves to conduct and support the vessels of the brain, and allows them to divide into such minute parts, as to prevent the blood from entering the tender substance of this viscus with too great force.

The arteries of the pia mater are the same with those of the brain, and are derived from the internal carotids and vertebrals.

The veins differ in no respect from those of the other viscera, excepting in this, that they do not accompany the arteries.

From the dura mater certain membranous processes go off, forming incomplete partitions, which partially divide the cavity of the cranium; and in the same partial manner, separate the parts of the brain from each other: thus preventing them from pressing upon each other, and keeping them steady.

They are formed of the internal lamina or layer of the dura mater, like a plait, and therefore each of them consists of a double membrane.

The most conspicuous of these is denominated the *falx*, which extends from the anterior to the posterior part of the cranium, and divides the upper part of the brain into two hemispheres: but it is not sufficiently deep to divide the whole of the brain; for, between the under edge of it, and the base of the cranium, there is a large space occupied by a portion of the brain, which is undivided: and, therefore, common to both hemispheres.

The falx begins at the middle of the sphenoid bone, and, continuing its origin from the crista galli of the ethmoid bone, runs along the upper and middle part of the head; adhering first to the frontal, then to the joining of the parietal, and afterwards to the middle of the occipital bone.

In its passage it becomes gradually broader, and terminates behind, in the middle of the tentorium.

It runs from before backwards in a straight direction, and has

some resemblance in shape to a sickle or sithe, placed with its edge downwards; from which circumstance it has obtained the name of *falx*.

After extending backwards as far as the centre of the crucial ridge, on the internal surface of the occipital bone, it extends to each side, and forms a horizontal partition, which partially divides the lower part of the cavity from the upper: but it does not extend so far forward, as to separate, completely, the mass which is under it, or the *cerebellum*, from the upper part of the brain, or *cerebrum*.

This horizontal membrane is called the *tentorium* and also the *transverse septum:* it is connected behind to the inner transverse ridges and grooves of the occipital bone, and, at the fore and outer edges, to the ridges and great angles of the temporal bones, and terminates at the posterior clinoid process of the sphenoid bone.

Between the inner edge of the tentorium and the posterior clinoid process of the sphenoid bone, there is a large notch, or foramen ovale, where the brain and cerebellum are united, or where the *tuber annulare* is chiefly situated.

The tentorium keeps the falx tense, and forms a floor or vault over the cerebellum, which prevents the cerebrum from pressing upon it.

The *falx minor*, or *septum cerebelli*, is placed between the lobes of the cerebellum. It descends from the under and back part of the falx in the middle of the tentorium, adheres to the inferior longitudinal spine of the os occipitis, and terminates insensibly at the edge of the foramen magnum of that bone.

Besides the process of the dura mater already described, there are four of inferior consideration; two of which are situated at the sides of the sella turcica, and two at the edges of the foramina lacera.

As these partitions arise like plaits from the internal surface of the dura mater, there must necessarily be a cavity, larger or smaller, between the external layer of the dura mater, which lines the internal surface of the cranium, and the basis of the partition which arises from it: this cavity must continue along

the whole basis of the partition, and a section of it will be triangular.

This cavity is of considerable size at the upper edge of the falx, where it rises from the dura mater, and also where it forms the tentorium; and at the posterior edges of the tentorium, where it adheres to the occipital bone.

The cavity at the upper edge of the falx is called the *longitudinal sinus;* that at the posterior edge of the tentorium forms two cavities, called the *transverse sinuses;* and that which is at the junction of the falx and tentorium has the name of the *torcular*, or *press of Herophilus.*

The veins of the brain open into these sinuses; and the blood flows through them into the internal jugular veins. They differ from veins principally in this: that they are triangular, and, by the tension of the dura mater, are protected from pressure.

The principal sinuses are,

1. The longitudinal sinus, which begins at the crista galli, and, running along the upper edge of the falx until it arises at the tentorium, increases gradually in size, and terminates in the two lateral sinuses. [In this sinus, and beneath the dura mater near the top of the head, are many small bodies of various sizes called glandulæ Pacchioni. They are of various dimensions, from a line and less to three or four lines in diameter. One of the largest of these glands on each side protrudes through the dura mater from the surface of the brain, and makes a pit in the os parietale. Vesalius demonstrated these bodies in 1543. Pacchioni also demonstrated them fifty years afterwards; and, claiming them as a discovery of his own, succeeded in attaching his name to them.]

2. The two lateral sinuses run in depressions of the occipital and temporal bones, until they terminate in the internal jugular veins at the foramen lacerum.

3. The torcular Herophili, which receives a large vein from the interior of the brain, and is situated at the junction of the falx and tentorium, opening into the longitudinal sinus, where it divides into the lateral sinuses.

These are the largest sinuses of the dura mater; but, in addition to these, there are several small sinuses: as,

4. The inferior longitudinal sinus, which is situated at the under edge of the falx, and receives blood from the central parts of the cerebrum; it terminates in the torcular Herophili, near the beginning. The other small sinuses are situated under the brain; viz.

5. The circular sinus of Ridley,* which frequently surrounds the pituitary gland, and carries the blood from the contiguous parts to the

6. Cavernous sinuses, which are placed at the sides of the sella turcica, surrounding the carotid arteries and the sixth pair of nerves, and receive blood from the circular sinuses and several contiguous parts, and discharge it into the

7. Inferior petrous sinuses, which are placed at the bases of the partes petrosæ, and discharge this blood into the ends of the lateral sinuses. To these should be added

8. The superior petrous sinuses, which are situated on the upper edges of the petrous bones. They communicate both with the lateral and the cavernous sinuses, and receive some small veins from the adjacent parts.

There are also several small sinuses near the great occipital foramen, which communicate with the lateral sinuses, and also with the vertebral veins. They are called *occipital sinuses.*

The brain or the whole of the soft substance contained within these membranes, is composed of four portions, viz. *cerebrum*, *cerebellum*, *tuber annulare* or *pons Varolii*, and *medulla oblongata.*

Of the Cerebrum.

The *cerebrum* completely fills the upper part of the cavity of the cranium. It has some resemblance to the half of an egg, which has been divided horizontally; and is composed of two equal parts, which are separated vertically from each other by the falx. This vertical separation does not extend through the centre of the cerebrum, although it divides it completely before

* An English anatomist, who flourished near the end of the 17th century.

and behind. A portion of the central part of the cerebrum, which is situated deeper than the under edge of the falx, is not divided.

The upper surface of the two hemispheres is convex. The under surface is rather irregular; it is divided in each hemisphere into three lobes: the *anterior*, the *middle*, and the *posterior*.

The anterior lobes of the brain are situated on the front part of the base of the cranium, principally on the orbitar processes of the os frontis.

The middle lobes are lodged in the fossæ formed by the temporal and sphenoid bones.

The posterior lobes rest chiefly upon the tentorium, over the cerebellum.

Between the anterior and middle lobes is a deep furrow, corresponding to the base of the cranium on which they rest, which is called the fossa Sylvii.

The surface of the brain resembles that of a mass of small intestines, or of a convoluted cylindrical tube: it is, therefore, said to be convoluted. The fissures between these convolutions do not extend very deep into the substance of the brain.

The whole surface of the brain, thus convoluted, is covered by pia mater; which is connected to every part of the surface by an infinite number of small vessels and processes, that appear when this membrane is peeled off from the surface of the brain.

The mass of the brain consists of two substances of different colours; one of which is, for the most part, exterior to the other. The exterior substance is of a light brown colour, and is therefore called *cineritious*, or cortical, from its situation.

The internal substance is white, and is denominated the *medullary*.

The proportion of this medullary part is much greater than that of the cortical. The cortical, however, surrounds it, so as to form the whole of the surface of the cerebrum, that can be strictly said to be exterior.

The colour of the cortical part appears to be derived from the blood; as its intensity seems regularly proportioned to the quantity of blood in the head. In subjects who have been plethoric,

or have had a determination of blood to the head, it is uniformly high-coloured; in pallid and exhausted subjects it is of a brighter colour.

The medullary matter is uniformly white; but small red points appear upon its surface, when cut, which are the sections of vessels which carry red blood: and these points are larger and more numerous in plethoric, than in exhausted subjects. It is rather firmer than the cortical substance.

These two substances are most intimately connected in the cerebrum, and indeed seem to be a continuation of each other. In some parts they are blended together; and in other places, there are portions of cortical matter within the medullary.

The division of the cerebrum into two hemispheres extends to a considerable depth from above, and also to a considerable distance internally, from its anterior and posterior extremities; of course, the part which is undivided is in the centre.

The cortical part covers also the surfaces, which are in the great fissure that forms the two hemispheres, and is occupied, in a great degree, by the falciform process of the dura mater. Towards the bottom of this fissure, and below the falx, these surfaces being opposed to each other, and in contact, are slightly united by adhesion of the membranes that cover them.

The central part, which is not divided, and which must appear at the bottom of the fissure, when the two hemispheres are separated from each other, is medullary; being evidently a union of the medullary matter of each hemisphere. This undivided medullary part is equal to about one half of the length of the hemispheres; the fissures at each extremity extending inwards, about one-fourth of their length. On each side of it, a fissure, equal to it in length, extends horizontally into the medullary matter in each hemisphere, about half an inch; the whole of this unconnected surface, the middle of which is directly at the bottom of the great fissure, is termed *corpus callosum.*

When the hemispheres are cut away to the level of this surface, and the corpus callosum is examined, two raised lines appear in the middle, which extend from one end of it to the other; and between them is a small groove of the same length. This

groove is called the *raphe*, or *suture* of the corpus callosum. From the raised lines or bands on each side of the raphe, small lines less elevated pass across the corpus callosum, and are lost in the medullary matter. The hemispheres being thus cut off at the level of the corpus callosum, on the cut surface is to be seen the interior mass of medullary matter, with the cortical part exterior, its edge exhibiting the convoluted surface of the brain, and the pia mater, following the convolutions.

The medullary surface, thus exhibited, with the corpus callosum in the centre, is denominated the *centrum ovale.*

In the brain there are four cavities called *ventricles:* three of these are formed in the substance of the cerebrum: the fourth is situated between the cerebellum, the pons Varolii, and medulla oblongata. The two largest are called the *lateral ventricles,* from their situations; the others are named, from the order in which they occur, the *third* and the *fourth ventricle.*

The lateral ventricles are cavities of an extremely irregular figure: they are situated in each hemisphere a little below the level of the corpus callosum: and, with the exception of the partition which separates them, are directly under it. They commence anteriorly, nearly on a line with the termination of the fissure that separates the two hemispheres anteriorly; and continue backwards almost as far as the commencement of the fissure that separates them posteriorly: when they have attained this length posteriorly, they form a considerable curve, first outwards, then downwards, and afterwards forwards, so that they terminate almost as far forwards as they commenced; but much deeper.

At the posterior part of their curve, when they incline outwards, previous to their turn downwards, a process or continuation of the cavity extends backwards, almost as far as the cerebrum does itself. These elongations are called the posterior *cornua* or *sinuses,* or the *digital cavities.*

Each ventricle may, therefore, be divided into three parts, viz. The portion under the corpus callosum; the portion which continues outwards and downwards, and terminates below it: and the posterior portion.

It has been compared to a ram's horn, by some who have contemplated particularly the upper and lower portions of the cavity; and by others who have had the whole extent in view, it has been called *tricornis.*

The bottom, or lower surface of these cavities, is varied in almost every part of its extent. The front part of the bottom of each ventricle is a broad and convex eminence, which becomes narrower as it proceeds backwards; so that it resembles a portion of a pear. It inclines outwards as well as backwards, so that the narrow posterior extremities of the two bodies are farther from each other than the anterior broad extremities.

The colour of these bodies is cineritious externally; but they are striated with medullary matter within, and therefore are called *corpora striata.*

Between their posterior extremities are two other eminences, which incline to the oval form, and have a white or medullary colour; although their substance, when cut into, is slightly striated: they are called the *thalami nervorum opticorum.* These bodies are very near each other: and, being convex in form, are in contact at the centre: they adhere slightly to each other; and this adhesion is called the *soft commissure,* (*commissura mollis.*)

The corpora striata, and the thalami nervorum opticorum, join each other at the exterior sides of the thalami: where they are in contact, there is the appearance of a narrow medullary band, which continues during the whole extent of their connexion: it has been called, by some, *tenia semicircularis,* from its form; by others, *centrum geminum semicirculare.*

These surfaces constitute the bottom or floor of the first portion of the ventricles, which is under the corpus callosum: upon this floor is laid a thin lamina of the medullary matter, of a triangular form, called the *Fornix,* which covers the thalami nervorum opticorum, and is attached to them by a membrane; so that when the ventricles are opened, the bottom appears to consist of the corpora striata, and the fornix.

The upper surface or roof of the ventricles is concave; from the middle of it, immediately under the raphe of the corpus callosum, there proceeds downwards a partition of medullary matter,

which separates the two ventricles from each other. This is called *septum lucidum*, from its being nearly transparent: below, it adheres to the fornix, and anteriorly, it is continued into the medullary matter, between the corpora striata. This septum lucidum is formed of two lamina or plates, which are separated from each other in the anterior portion of the septum, and thus form a small cavity, which has no communication with the other cavities of the brain.

The fornix is not perfectly flat, but accommodated to the surface of the thalami nervorum opticorum; its under surface is rather concave, and its upper surface convex. The anterior angle passes down between the most anterior parts of the thalami nervorum opticorum, and is divided into two small portions called its *crura*, which can be traced some distance in that part of the brain.

The body of the fornix is attached to the surfaces of the thalami nervorum opticorum, on which it rests by a very vascular membrane, which is spread over the thalami, and called *tela choroidea* and *velum interpositum*. At the edges of the fornix, there are many blood-vessels in the membrane, arranged close to each other, which are called the *plexus choroides*.

The posterior side or edge of the triangular fornix terminates in the corpus callosum, or the medullary matter which is above it at that place; but the under surface is attached throughout to the parts on which it lies, by the aforesaid membrane.

The two posterior angles of the fornix form what are called the *crura*, and they terminate in the following way.

The surfaces of the inferior portions of the lateral ventricles are not uniformly concave; but at the bottom of each there is a prominent body, which begins where this portion of the cavity winds outwards and forward, and continues its whole extent. This prominence has a curved form, and is marked by transverse indentations towards its extremity; hence it has been termed the *hippocampus*, or *cornu ammonis*.

A similar prominence, but smaller, and without the transverse indentations, is to be found in the posterior portion of the ventricle: this has, also, been called *hippocampus*; but the terms *minor* and *major* are applied to distinguish them.

The posterior angles of the fornix terminate in the large hippocami; and the margin or thin edge of the two anterior sides of the fornix, is continued to form an edge to the hippocampus; and is called the *tænia hippocampi*, or *corpus fimbriatum.*

The word fornix was the ancient name of a vault, or arch; and, from its supposed resemblance to an arch, this part has been called by that name.

When the fornix is raised up, which must be done by dividing it at the anterior angle, and detaching it from the thalami nervorum opticorum, by dissecting the *velum interpositum*, the thalami are brought fairly into view, and appear like oval bodies placed parallel to each other. They adhere slightly at their upper surfaces, and, when separated, a fissure appears between them, which is the third ventricle. At the upper and front part of this third ventricle, near its commencement, before the anterior crura of the fornix, and very near them, is a white chord, like a nerve, which passes across the ventricle, and can be traced to some distance on each side of the medullary matter of the brain.

This chord is called the *anterior commissure of the brain.* The thalami nervorum opticorum being of an oval form, and touching each other in the middle, there must be a vacuity between them at their extremities. This vacuity is behind the anterior crura of the fornix, and has been called *Vulva*, *Iter ad Infundibulum*, and *Iter ad Tertium Ventriculum.*

It leads, of course, into the third ventricle; but a passage continues from it downwards and rather forwards, to the infundibulum; which is a process somewhat resembling a funnel that is composed principally of cineritious substance, and passes from the lower and front part of the third ventricle, towards the sella turcica; in which is situated the small body called the *Pituitary Gland.*

The infundibulum is hollow at its commencement, and solid at its extremity near the gland.

The adhesion of the thalami nerv. optic. to each other, at the upper part of the third ventricle, has been denominated the *Commissura Mollis.* The recession from each other at their posterior extremities, in consequence of their oval figure, forms another

opening into the third ventricle, when the fornix and tela choroidea is raised, which is closed when they are in their natural situations upon it.

In the back part of the third ventricle is another medullary chord, called the *Posterior Commissure*, which appears much like the anterior commissure; but does not extend into the substance of the brain in the same way. Under this chord, or posterior commissure, is a passage which leads to the fourth ventricle, called *Iter ad Quartum Ventriculum*, or *Aqueduct of Sylvius.*

Behind the third ventricle, and terminating it posteriorly, are four convex bodies, called *Tubercula Quadrigemina*, or *Nates* and *Testes:* the nates are uppermost and most convex; the testes are immediately below, and somewhat oval transversely.

The nates and testes are situated so far backwards that they are near the anterior part of the upper surface of the cerebellum, and the anterior edge of the middle of the tentorium. The posterior part of the fornix is directly over them, but it unites with the medullary matter of the cerebrum above it; there would, therefore, be a passage into the lateral ventricles from behind, between the back of the fornix which is above, and the nates and testes which are below; but the velum interpositum passes in from behind, and attaches the lower surface of the fornix to all the parts on which it lies; and thus closes the ventricles at this place. In this membrane, immediately over the posterior end of the fissure called the *third Ventricle*, and in contact with the nates, is the *Pineal Gland.* This body is not so large as a pea, and is formed like a pine-apple, or the cone of a pine tree.

When the fornix is raised, by dissecting the membrane, it may be elevated with the membrane and fornix.

The nature of this body is not understood: it resembles a small gland in its appearance, but it is very soft; and particles of sand-like matter are often found in it.

There is a small chord on each edge of the third ventricle, which appears to proceed from the pineal gland, and continues on the edge of the ventricle to the anterior crura of the fornix, to which it unites. These chords join each other under the pineal gland: they are called the *pedunculi*, or *footstalks* of the pineal gland.

The membrane connected with the pineal gland, it has been said, is the *tela choroidea*, or *velum interpositum*, in which the plexus choroides is placed, at the edges of the fornix. This membrane is extended, somewhat thinner and less vascular, so as to line the surface of the ventricles. The plexus choroides appears to begin at the end of each of the inferior portions of the ventricles, where the pia mater penetrates from the basis of the brain: it proceeds into the upper portions of the ventricles, and continuing along the edge of the fornix, passes under that body at its inferior angle, and meets the plexus of the opposite side. Between this meeting of the plexus, and the crura of the fornix, is a vacuity of an oval figure, which forms a communication between the ventricles of the brain. Under this vacuity or foramen, the thalami nerv. optic. recede from each other, and from the anterior passage into the third ventricle, described at page 351, so that at this place the three ventricles communicate with each other.

From the plexus choroides of each side, where it has passed under the fornix at the anterior angle, a large vein is turned backwards, so as to run nearly over the fissure of the third ventricle towards the pineal gland. Several veins from the surface of the ventricle join this vein near its commencement; thus formed, it passes along with the corresponding vein from the opposite side, sometimes in contact and sometimes separated to a small distance; near the pineal gland, these veins unite into one trunk, the great internal vein of the brain, called the *Vena Galeni:* which terminates soon after in the torcular Herophili.

Of the Cerebellum.

The cerebellum is situated in the lower and posterior part of the cavity of the cranium, in contact with that portion of the os occipitis which is below the groove for the lateral sinuses. It is, of course, much less than the brain.

It is covered above by the tentorium, and is divided below into two lobes, by the falx minor.

The surface of the cerebellum differs in some respects from that of the cerebrum. Instead of the convolutions, there are

small superficial depressions, which are nearly horizontal, tending to divide the cerebellum into strata. The pia mater extends into these depressions; and the tunica arachnoidea passes over them, as in the cerebrum.

The exterior part of the cerebellum is composed of cineritious or cortical, and the internal or medullary matter, as is the case with the cerebrum: but the proportions of these substances in the cerebellum, are the reverse of what they are in the cerebrum.

If sections be made in the cerebellum, the medullary matter is so arranged that it appears like the stem or trunk of a plant, with ramifications extending from it. This appearance has been called the *Arbor vitæ.*

On the basis of the brain is a part called *Tuber Annulare*, or *Pons Varolii*, which is formed by processes from the cerebrum, and cerebellum; and is in contact with the anterior and inferior portion of the cerebellum in the middle. From this part the medulla oblongata proceeds downwards and backwards, under the cerebellum: and between the cerebellum, the medulla oblongata, and the pons Varolii, is the vacuity, called the *fourth ventricle* of the brain.

When the brain is in its natural situation, this cavity is below and behind the nates and testes; and from the cerebellum there passes up to the testes, a lamen of medullary matter, which closes it above. This lamen is called the *Valve of Vieussens*, or the *Valve of the Brain.* Below, the ventricle is closed by a membrane, which connects the medulla oblongata to the cerebellum.

There is a passage into this cavity from the third ventricle, which passes under the posterior commissure, and the nates and testes, and enters it below the testes.

Of the Basis of the Brain, and the Nerves which proceed from it.

When the brain is detached from the basis of the cranium, and inverted, (which can be readily done, if the nerves that proceed from it are divided, as it is inverted,) the tunica arachnoidea appears more conspicuous on the basis than it is on the upper part; and the pia mater is disposed round the convolutions in the same manner that it is above; but the nerves and vessels

connected with the surface of the brain are so much involved with these membranes, that considerable dissection is required to expose them properly.

The anterior and middle lobes of the brain are very conspicuous on the inverted surface. The anterior lobes appear separated from each other by the extension of the great fissure which forms the two hemispheres. The middle lobes appear at some distance from each other in the centre; and the cerebellum forms the posterior and most prominent part of the surface.

When the brain has been carefully detached from the cranium, and the nerves adhering to it are preserved, the *olfactory* or *first* pair* of nerves, appear on the anterior lobes, running nearly parallel to each other at a small distance from the great fissure. They are flat, and thin, and soft, in their texture; their breadth is rather more than one-sixth of an inch. They pass in three divisions from between the anterior and middle lobes of the cerebrum, which soon unite and run to the cribriform plate of the ethmoid, where they expand into soft bulbous lobes, from which proceed the fibres that perforate the cribriform plate, and are spread upon the Schneiderian membrane.

Behind the olfactory nerves are the *optic*. Each of which come out between the anterior and middle lobes of the cerebrum; and after bending so as to meet its fellow, turns off and passes through the optic foramen in the sphenoidal bone. These nerves can be traced in the brain to the thalami nerv. optic.

In the angle formed by the optic nerves posteriorly, is a mass of softish cineritious matter (*pons Torini*); and also the infundibulum which passes to the sella turcica.

In this soft cineritious matter are two round white bodies that resemble peas; which are called the *Corpora Albicantia of Willis*, or the *Eminentiæ Mammillares*. Behind these bodies are two large medullary processes, called the *Crura Cerebri*, which are best seen if some of the cortical part of the adjoining middle lobes is dissected away. They come from the medulla of the opposite sides of the brain, and gradually approach each other until they arrive at the tuber annulare, or pons Varolii.

* The nerves are numbered from before.

The Pons Varolii* is a mass of considerable size, which has a medullary appearance externally, but is striated within: it is formed by the union of the two above mentioned crura cerebri, and of two similar processes derived from the cerebellum, called also its *Crura*. It lies over a part of the body of the sphenoid bone, and of the cuneiform process of the occipital bone, and under a portion of the middle lobes of the cerebrum and of the cerebellum. There is a longitudinal depression on its surface, made by the basilar artery; and there are also many transverse streaks on it.

The crura of the cerebellum, which runs into this substance, are evidently continued from the arbor vitæ or medulla of the cerebellum.

The anterior edge of the cerebellum, part of which is in contact with the pons Varolii, is remarkably prominent on each side of it. These prominences are called the *Vermes* of the cerebellum.

The medulla oblongata is continued backwards from the posterior side of the tuber; and somewhat resembles a truncated cone inverted.

It lies on the cuneiform process of the occipital bone, and extends to the foramen magnum. It is indented lengthwise, both anteriorly and posteriorly, by fissures which are very evident: it is composed of medullary matter externally, and cineritious matter within.

On each side of the anterior fissure, which is in view when the brain is inverted, are two oblong convex bodies: those which are next to the fissure are called the *Corpora Pyramidalia*, and are the longest; the two exterior are called *Corpora Olivaria*, and are not so long.

The *third pair of nerves* come from between the crura of the cerebrum, and pass forward, diverging from each other. They proceed by the cavernous sinus, and, after penetrating the dura mater, go out of the cranium at the foramen lacerum.

The *fourth pair*, the smallest nerves of the brain, resemble sewing thread in their size and appearance. They come out

* Named from Varolius, physician to Gregory VIII. in 1573.

between the cerebellum and pons Varolii, but can be traced backwards as far as the testes. They proceed forwards by the sides of the pons Varolii, and after penetrating the dura mater near the posterior clinoid apophysis, pass through the foramen lacerum to the trochlearis muscles of the eye.

The *fifth pair*, the largest of the brain, arise from the crura of the cerebellum, where they unite with the pons Varolii: they pass forwards and downwards, and penetrate the dura mater near the point of the petrous portion of the temporal bone.

This nerve appears like a bundle of fibres; and, under the dura mater, forms a plexus; from which its three great branches proceed to their destination.

The *sixth pair* arise from the medulla oblongata, where it joins the pons Varolii. It is often composed of two chords on each side, one of which is very small; they pass under the pons Varolii, and through the cavernous sinus, with the carotid artery: after emerging from this sinus they proceed through the foramen lacerum to the abductor muscles of the eye. In this course a small twig passes from it, which accompanies the carotid artery through the canal in the petrous portion of the temporal bone, and with a twig from the fifth pair, is the origin of the intercostal nerve.

The *seventh pair* appear at the side of the medulla oblongata, near the pons Varolii. It is composed on each side of two chords, called *Portio Dura* and *Portio Mollis*, and of one or more small fibres between them, called *Portio Media*. The portio mollis can be traced to the fourth ventricle. The portio dura seems to arise from the place of union of the pons Varolii with the medulla oblongata and the crura cerebelli. The portio media appears to originate in the same neighbourhood, and may be considered as an appurtenance of the portio dura. They all proceed to the meatus auditorius internus, as it has been called, in the temporal bone.

The *eighth pair of nerves* arise from the corpora olivaria on the side of the medulla oblongata. They are composed in each, of one chord called the *Glosso-Pharyngeal*, and of a considerable number of small filaments, which unite and form another chord called the *Par Vagum*.

With these nerves is associated a third chord, called the *Spinal Accessory Nerve* of Willis, which passes up the spinal cavity, being composed of twigs from the posterior and anterior portions of almost all the cervical nerves.

The par vagum, with this nerve and the glosso-pharyngeal, proceeds from its origin to the foramen lacerum formed by the occipital and temporal bones; where they all pass out of the cranium; separated from each other, and from the internal jugular vein, by small processes of the dura mater.

Their destination is extremely different. The glosso-pharyngeal is spent upon the tongue and pharynx; the par vagum upon the contents of the thorax and abdomen, &c., while the accessory branch, which seems to have no connexion with them, perforates the sterno-mastoid muscle, and is distributed among the muscles of the shoulder.

The ninth pair arise from the corpora pyramidalia by many filaments, that are united on each side into three or four fasciculi, which perforate the dura mater separately, and then unite to pass out of the anterior condyloid foramen of the occipital bone: this pair is spent upon the muscles of the tongue.

Within the last three or four years, there have been many allusions in the public papers, to the discoveries of Dr. Gall, formerly of Vienna, respecting the brain. For information concerning these discoveries, the reader is referred to a very learned and judicious Memoir, presented to the class of Mathematical and Physical Sciences of the National Institute of France, by Messrs. Tenon, Portal, Sabatier, Pinel, and Cuvier.

A translation of this report has been published in the fifth volume of the Edinburgh Medical and Surgical Journal for 1809. See, also, Lessons in Practical Anatomy by the present editor, part I.

Galen taught that there were two motions in the brain, one caused by the pulsation of the arteries, the other by respiration, the air being admitted into the ventricles through the ethmoidal and sphenoidal cells. Vesalius and Fallopius refuted the latter opinion and exposed its error. In 1744, Mr. Schlichting, of Amsterdam, announced to the Royal Academy of Sciences of Paris, that the brain was elevated in expiration and depressed in inspiration. MM. Haller and Lamard repeated his experiments, and found that the motion of the brain depended on a reflux of blood through the internal jugulars, in cases of laborious respiration, besides the common motion from the pulsation of the arteries.—See Discours sur l'Anatomie par Lassus.—H.

CHAPTER XIII.

OF THE SPINAL MARROW.

The medulla oblongata is continued from the cavity of the cranium, through the great foramen of the occipital bone, into the great canal of the spine; when it takes the name of *Medulla Spinalis*, or *Spinal Marrow*.

The dura mater passes with it through the great foramen, and encloses the whole of it. At the commencement of the spinal canal this membrane is attached to the surrounding bones; viz. to the margin of the great occipital foramen, and to the atlas; but below this it is loosely connected by a membrane which sometimes appears to contain a little adeps. The tunica arachnoidea and the pia mater also invest the medulla spinalis. The arachnoidea appears unconnected with the dura mater; and it can easily be removed from the pia mater. The pia mater adheres rather firmly to the substance it encloses.

The spinal marrow consists of medullary matter externally, and cineritious or cortical matter internally.

The fissures which are observable, anteriorly, and posteriorly, in the medulla oblongata, are continued down the spinal marrow; dividing it partially into two lateral portions: these fissures penetrate to a considerable depth. Each of the lateral portions is marked on its external surface, by a more superficial fissure, which partially divides it into an anterior and posterior part; so that a transverse section of the spine has a cruciform appearance.

The nerves go off in fasciculi from the anterior and posterior surfaces of each lateral portion of the spinal marrow; so that each nerve is formed of two fasciculi: one from before, and the other from behind. The fasciculi are of different sizes in different parts of the spine. The lowermost of the neck are large and

broad; those of the back are slender: and those of the loins, and upper part of the sacrum, are very large.

The uppermost of the fasciculi of the spine proceed almost at right angles with the medulla spinalis, to the foramina through which they pass: those which are lower pass off in a direction obliquely downwards; and the lowermost are almost perpendicular. Between the anterior and posterior fasciculi, a fine ligamentous chord passes, which is attached above to the dura mater as it passes through the foramen magnum, and continues to the os coccygis. It passes between the tunica arachnoidea and pia mater, attached to the pia mater by cellular membrane. It sends off a small process in a lateral direction, to be attached to the dura mater in the interstices between the places where the fasciculi pass through the dura mater, and nearly in the middle between the upper and lower fasciculi.

The spinal marrow terminates in a point near the uppermost lumbar vertebra. The ligamenta denticulata of the opposite sides join each other at this point, and form a small chord, which, continuing downwards, is inserted into the os coccygis.

These ligaments may support, and keep fixed, the medulla and the nerves, as they originate from it.

As the spinal marrow terminates at the upper lumbar vertebra the lumbar and sacral nerves go off above: they pass down like a bunch of straight twigs, and are called *Cauda Equina*, from a fancied resemblance to the tail of a horse. The sheath, formed by the dura mater for the spinal marrow, continues of its original size, and encloses them in one cavity.

The posterior and anterior fasciculi pass out separately from the dura mater; after they are out, the posterior fasciculus forms a ganglion; from which one nerve passes that joins the anterior fasciculus, and thus forms the spinal nerves.

When the nerves go off, either from the spinal canal, or the cavity of the cranium, the external lamen of the dura mater where they pass out, attaches itself to the bone or the periosteum; while an internal lamen, together with the pia mater, and, perhaps, the tunica arachnoidea, is continued with the nerve.

This process from the dura mater becomes so much changed, that it has been considered as cellular membrane.

The pia mater and tunica arachnoidea seem also to invest, not only the nerve in general, but the fibres of which it is composed. On this account, probably, the nerves are larger after passing through the dura mater, than they are when they leave the brain and spinal marrow.

The arteries of the Spinal Marrow proceed from the head, and, with several additions, continue downwards to the lumbar vertebræ.

There is, generally, one artery on the front surface of the medulla, which is formed by the union of two branches, that arise from the vertebral arteries within the cranium. This artery proceeds downwards and communicates with those of the neck, and with the intercostal arteries, by the intervertebral foramina, so that it preserves its size.

It terminates with the spinal marrow; and the cauda equina below it, is supplied by branches from the internal iliac, which enter through the foramina of the sacrum.

There are, generally, two arteries on the posterior surface of the medulla spinalis, which also pass out from the cranium; arising from the vertebral arteries or inferior arteries of the cerebellum; they have a serpentine arrangement, and communicate with each other, and with the ramifications of the anterior spinal artery.

All of these arteries are dispersed upon the spinal marrow and its membrane, and the parts immediately contiguous.

The veins correspond with the ramifications of the arteries; but they are collected into two larger branches called the *Sinus Venosi;* which are situated exterior to the dura mater, on the front and lateral sides of the spinal canal. They extend the whole length of the canal, and entering the great occipital foramen, communicate with the lateral and occipital sinuses.

CHAPTER XIV.

OF THE EYE.

It will be very proper to read the description of the orbit of the eye at page 106, volume 1st, as an introduction to the following description of the organ.

In addition to that account of the bones, it is to be observed that processes of the dura mater pass through the foramina optica and lacera, which line the cavity of the orbit, and unite with the periosteum at the margin of it.

The eye is an optical instrument of a spherical form, which lies in the orbit, in the bed of cellular membrane, more or less filled with adeps for the convenience of its motions. Connected with the ball of the eye, are several auxiliary parts which are calculated for its motion and protection, as well as accommodation in other respects.

Of the parts auxiliary to the Eye.

Above the upper margin of the orbit, on the prominences of the os frontis, called *superciliary ridges*, the adipose membrane is commonly more full than it is in the other contiguous places; and the skin which covers it is thereby rendered prominent.

The *supercilia or eyebrows* grow out of this prominent skin. The hairs which compose them are placed obliquely, with their roots towards the nose. Their principal use seems to be to defend the eye from sweat, and other matters which roll down the forehead. They are moved by the corrugator muscle, and thus express certain passions; and they are also moved by the occipito-frontalis and orbicularis palpebrarum.

—The extent and degree of curvature of the eyebrows, differ much in different individuals. The hairs of which they are composed, are short, curved, highly elastic, and arranged in rows,

the middle of which are the longest. The internal extremities of the eyebrows, called the head, occasionally meet; but most usually, there is an interval between them called *glabella*, which presents the smoothness and polish of other parts of the forehead, and adds to the open and noble expression of the face. The outer extremity or tail is terminated by a thin series of hairs, (cauda supercilii) near the outer angle of the frontal bone. The colour corresponds generally with that of the hair.—

The Eyelids or Palpebræ,

Are formed by a slit or orifice in the skin (*fissura palpebrarum*); immediately under the skin, surrounding this orifice, is a portion of the orbicularis muscle; under this portion of the muscle, there is a plate of cartilage, and under the cartilage, a portion of tunica conjunctiva, or membrane that covers the front part of the ball of the eye and lines the eyelids.

—The eyelids, may be considered two movable fleshy curtains, nicely adjusted to one another at their free edges, and to the anterior surface of the ball of the eye, which they exactly cover. —They are composed of the skin externally, which is so thin as to allow the light partially to pass through it, and which is folded inwards at the free margin of the lids, so as to line their inner surface, where it takes the character of mucous membrane, (*tunica conjunctiva*); from the lids, it is reflected again over the anterior surface of the eyeball, so that the conjunctival linings of both eyelids form one continuous membrane. The lids are two in number, upper and lower, *palpebra superioris*, *palpebra inferioris.* They are divided unequally by the transverse fissures; so that the upper lid is considerably the larger. Was it not for this, as the motions of the lower lid are very limited, the eye would be only half uncovered, in what is called, opening the eye.

—The fissure which separates the lids is not exactly transverse; it is slightly depressed externally. The reverse is said to be the case in regard to the Chinese, in whom the peculiar expression of the eye depends upon the depression of the internal angle below the level of the outer.

—The cellular tissue of the eyelids is very lax, but comprises none of the adipose. Hence the lids may suffer from œdematous or sanguineous effusions, but are never burthened with fat. The two lids unite at the extremities of the transverse fissure, and from two angles, or *canthi*, the internal of which is the largest, and is call the *great canthus.* This is owing to the insertion of the orbicularis at the internal canthus upon a round tendon, which does not exist at the outer.—

The upper eyelids, therefore, are composed of the skin, of some fibres of the orbicularis muscle, of the tendon of the levator palbebræ superior muscle, of the cartilaginous plate, and of the tunica conjunctiva. The under eyelid is formed in the same way, with the exception of the cartilage, which, in it, is confined to the margin. There is besides no muscle or tendon in this lid analogous to the levator palpebræ superioris.

These cartilages form the margin of each eyelid, which is called *Tarsus.* The upper cartilage is broad in the middle, and narrow at each extremity, and accommodated to the form of the eyeball and eyelid. The under cartilage is a narrow flat rim, which does not extend far from the margin of the eyelid. A thin delicate membrane is extended from the upper and lower margins of the orbit to these cartilages, and has been considered as forming ligaments for them.

—These cartilages are closely connected together by some fibrous matter* at the external canthus, but terminate short of each other at the internal, by an attachment to the bifid extremity of the round tendon, in order to allow space for the lachrymal puncta and ducts. The superior tarsal cartilage, is much broadest in the middle, where it is about six lines wide. The inferior is about two lines in breadth, and is nearly of the same width in its whole extent. Their adhering borders, degenerate into cellular tissue, by which they are connected to the fibrous layer of the lids.

* This fibrous matter, is part of a thin ligamentous expansion continuous with the periosteum of the socket, attached to the margin of the tarsal cartilages, and placed between the conjunctiva and orbicularis muscle. It is sometimes called *ligamentum latum palpebrarum.*—P.

They present on their inner surface a number of vertical grooves in which are lodged the glands of Meibomius.—

Their edges are formed obliquely, and apply to each other in such way, that when the lids are closed a groove is formed between them and the eye; by which the tears are conveyed towards the nose.

The use of these cartilages is to keep the eyelids properly expanded; and to form margins that apply accurately to each other.

These cartilages are covered internally by the tunica conjunctiva.

The levator palpebræ muscle, which arises from the bottom of the orbit, at the upper part of the foramen opticum, and passes over the superior muscle of the eyeball, is inserted by a broad thin tendon or aponeurosis into the cartilage of the upper eyelid, and draws it upwards, within the upper margin of the orbit, when the eyelids are opened.

The antagonist muscle to the levator or that which closes the lids, is the orbicularis palpebrarum.

The tunica conjunctiva, that lines the eyelids, is continued from them, without any interruption of the surface, over the anterior part of the ball of the eye; in the same manner that the reflected membranes are continued from one surface to another.

Although this membrane is a continuation of the skin, it is essentially different from its structure; being extremely thin, flexible, and sensible, and also transparent. It abounds with vessels, which do not carry red blood in their natural state, but receive it largely when they are inflamed or much relaxed. It adheres firmly to the cartilage at the edge of the eyelids; and becomes more loose in its adhesion to the lids, as it proceeds backwards. It is so reflected to the ball of the eye, that it covers and adheres to about one-third of it anteriorly. Where it first joins the eye, the adhesion is loose, but this adhesion becomes firmer as it advances over the eye; and it cannot be separated from the cornea without maceration, and a slight degree of putrefaction. The part immediately connected with the cornea is extremely thin and delicate.

This membrane closes the orbit of the eye, and completes the cavity which contains the muscles, lachrymal gland, &c., which are by this means precluded from contact with the external air. —The conjunctiva receives some very delicate nervous fibrils from the branches of the fifth pair, called the lachrymal and internal nasal. It contains, there is reason to believe, many mucous cryptæ or follicles, but from their minuteness, it is difficult to detect them. Stachow, however, asserts that with the microscope he has seen them *most distinctly*, though in the palpebral conjunctiva only. According to this observer they are most numerous in the upper lid, and in the neighbourhood of the tarsal cartilages; especially at their extremities.
—He found them in groups of 8, 12, or 15 together, and sometimes 50 or 60. That portion of the ocular conjunctiva which covers the sclerotica is sometimes called the *tunica adnata*.—

On the inside of each eyelid, apparently between the tunica conjunctiva and the cartilages, are a number of lines running inwards from the edge of the lid. These lines are of various lengths, from one-fourth to near half an inch; the longest are in the middle of the upper lid. Some of them are straight; and others are serpentine: their colour is a yellowish white. There are generally more than thirty in the upper eyelid, and more than twenty in the lower. They are called the *glands of Meibomius*.* By pressure a sebaceous substance can be forced out of them, in the form of fine threads, from orifices on the edges of the eyelids. They are follicles into which the sebaceous substance is secreted. This substance appears to have a twofold effect: it prevents the tears from running over the eyelid, as any other unctuous matter would do, and it prevents the eyelids from adhering to each other, in consequence of their contact during sleep.

—The orifices of these glands, are very minute, but will admit of the introduction of fine bristles. They are disposed in one or two ranges, immediately behind the eyelashes, and presenting

* Charles Etienne demonstrated the little sebaceous glands of the eyelids, and Casserius caused them to be drawn and engraved a long time before Henry Meibomius. The latter gave his name to them by a letter printed in Helmstadt in 1666, in which they were accurately described. See Lassus.—H.

toward the eyeball. These orifices lead into the little lines or ducts, which Meibomius described as glands. But the gland of Meibomius is now known to be a compound follicle, or rather a series of minute glands ranged parallel with each other upon the sides of the duct into which they open; some of which communicate together by lateral openings. The oily matter which they deposit on the edges of the lids, serves, in the ordinary state of the eye, to confine the tears, as water is known not to pass so readily over a vessel, the margin of which is greased.—

The *eyelashes* or *cilia* are placed near the outer edge of the lower part of the cartilages of each eyelid. They are always more or less curved, and their convexities are opposed to each other. By this arrangement the eye is defended from small external objects, and from light to a certain degree, without closing the lid completely.

—The cilia consists of three or four ranges of hairs irregularly placed, the middle of which are longest, and which gives to the brush of hairs, a pencillous arrangement. They are strongest and most numerous in the upper lid. Their bulbs or follicles are placed between the skin and tarsal cartilages;* and of course are not met with in the internal canthus. The lashes, or cilia are covered by an oily fluid, secreted by a number of little cuticular follicles, common to the roots of all hairs. This secretion tends to keep the hairs separate, and prevents that agglutination that would otherwise take place, from the drying of the lachrymal fluid, mixed as it is with the Meibomian secretion.—

It is necessary, for the perfection of the eye, that the whole surface covered by the tunica conjunctiva, viz. the anterior part of the eyeball and the internal surfaces of the eyelids, should be kept perfectly flexible and moist; for this purpose the lachrymal fluid is constantly secreted, in varying quantities, by the *lachrymal gland*, formerly called *Glandula Innominata*.†

* The tarsal cartilages thus intervene between the bulbs of the cilia and the Meibomian glands. And upon this is founded Berlinghieri's operation for the cure of Trichiasis, by the extirpation of the bulbs of the glands.—P.

† The necessity of this gland, exists only in land and amphibious animals, in which the eye is exposed to the evaporating effects of the air. In fishes, &c., it is not met with. The eyes in them being moistened by the fluid in which they live.—P.

This body is situated in a depression, in the upper surface of the orbit, near its external margin: it is exterior to, and above, the tunica conjunctiva. It is of an irregular oblong form, and rather flat; but it has some thickness. The under surface is lobulated, and forms two principal lobes.

From the anterior edge of the gland the excretory ducts, to the number of six or seven, pass off. They terminate at a short distance from the gland, near the upper end of the cartilage, and near the external angle of the eye. They do not communicate with each other.

Those ducts are so small, they are often not to be seen by the naked eye; but there is sometimes a chain of smaller glands, which lie between the gland and the eyelid, nearly in the direction of the ducts.

—The lachrymal gland, is about the size of a bitter almond, and consists in a great number of little fleshy granules of a reddish white colour, in which, the extreme branches of the arteries terminate, and from which, minute excretory ducts are believed to originate. The granules are separated from each other by processes of cellular tissue, which are sent in by the general cellular envelope of the gland, and by nerves and blood-vessels. The excretory ducts originating from these glandular grains, form by inosculation the six or seven ducts above mentioned, which open through the conjunctiva. The orifices in the conjunctiva, are readily seen in the eye of bullocks, but in the human eye, cannot well be discovered, without some artificial preparation.

—After immersing the human eye, for some time in water coloured with indigo, ink, or blood, the orifices become visible, and the ducts may be filled with mercury up to the gland. The ducts are three or four lines in length.—

The fluid secreted by this gland, (viz. the tears,) is transparent, but is always salt to the taste. When evaporated, by exposure to the air, some cubic crystals, and a small quantity of mucilaginous matter remain. Chemistry has ascertained that these crystals contain muriate of soda, and soda uncombined, and that phosphate of lime and phosphate of soda may be obtained by

burning inspissated tears; but the whole of the saline matter does not amount to one-hundreth part of the tears in which they are dissolved. The tears, therefore, consist of these salts, and of mucus, dissolved in a large proportion of water.

The tears are carried from the eye by two small canals, which commence, one on each eyelid, at the internal extremities of the cartilages, opposite to each other.*

The orifices of these canals, being in small cartilages, (but not in those called the tarsi,) are always open, and are called the *Puncta Lachrymalia.*

Each of these canals runs, within the edge of each eyelid, from the place of its commencement to the lachrymal sac, which is a larger membranous canal situated in the depression formed by the anterior portion of the os unguis and the corresponding portion of the upper maxillary bone; and extending thence along the bony canal, which continues from this depression into the nose, and terminates under the inferior spongy bone near its anterior extremity.

These canals are very small at their commencement at the puncta lachrymalia; but this small portion is very short; it forms an angle with the remainder of the canal, which is considerably larger.†

The canals gradually approach each other as they proceed towards the lachrymal sac, into which they enter, in contact with each other, but by distinct orifices.

—The orifices in the puncta are sufficiently large to admit readily a small bristle or probe. The ducts which lead from the puncta to the *lachrymal sac*, (see Fig. 1, Plate xiii,) are called *canalicula lachrymalia.* They are not straight; they commence by ascending perpendicularly in the upper, and by descending in the lower lid, for a line and a half; they are then turned at a right angle upon themselves, and pursue a course nearly horizontal to the lachrymal sac. Where the ducts turn

* The little hollow at the internal canthus, in front of the caruncle, and where the tears collect before entering the puncta, is called the *lacus lachrymalis.*—P.

† These canals were known to Galen, and were particularly described by Fallopius in 1584.—H.

to form the angle, a sensible dilatation takes place, in which are found one or two minute mucous cryptæ,* which sometimes embarrass the surgeon in operating through the ducts, the end of the probe or tube becoming entangled in the lower folds.—

About one-fourth part of the lachrymal sac is situated above the junction of the two eyelids, or the tendon of the orbicularis muscle; and the remainder below. After it descends below the orbit of the eye, it contracts and takes the name of the *Lachrymal Duct.*

—The lachrymal sac is ovoidal in its form, and closed at top; it rises about two lines above the round tendon of the orbicularis muscle, which is immediately in front of it, and feels like a grain of rice. Its diameter is about equal to that of a common goose-quill. Anteriorly it is covered by the integuments, the tendon above alluded to, and the orbicularis muscle. Externally it is bounded by the caruncle, and conjunctiva.—

The sac and duct have some resemblance to the Schneiderian membrane in structure; and are defended with a similar mucus. The membrane of which they are composed, adheres to the periosteum of the bony canal.

—Their walls are composed of two membranes, a mucous and fibrous; or rather of a mucous facing on a fibrous basis. The mucous membrane, is internal, contains a number of follicles, which secrete a lubrifying mucus, as in the urethra, and as in the latter organ are apt, when inflamed, to produce strictures or obstructions in the passage, and thus become one of the causes of fistula lachrymalis.

—The length of the nasal duct is from four to six lines; about equal to that of the sac. The direction of the duct in its bony canal, is downwards, backwards, and slightly inwards. At its termination in the inferior meatus of the nose, (about seven lines from the root of the nasal process of the upper maxillary bone,) the mucous lining membrane is thrown into a sort of valvular fold, which sometimes obstructs the introduction of a probe into it, from the nostril. The swelling of this valve, in

* Dalrymple, Anat. of Human Eye, p. 277. Lond. 1834.—P.

corysa, measles, &c., is said to be one of the causes of the accompanying epiphora.—

The tears appear to enter the puncta lachrymalia upon the principle of capillary attraction; and to be propelled forwards by the motion of the eyelids and the pressure of the orbicularis muscle.

Between the puncta lachrymalia and the termination of the eyelids, at their junction with each other, is a small angular space, which is occupied by a body called the *Caruncula Lachrymalis;* which is of a reddish colour, with a few small hairs growing out of it: it is supposed to be glandular, and to secrete a sebaceous substance. It has an effect in directing the tears to the puncta lachrymalia.

—The caruncula lachrymalis, consists of a collection of small mucous glands, seven in number—substitutes for the Meibomian glands which are deficient in the internal canthus. Six of these glands are placed upon a common level, and the seventh is seated upon the top of the rest near their centre, making the caruncle conoidal in shape, and about the size of a grain of wheat. —The conjunctiva is spread over them, and is pierced by a number of small apertures, which are the orifices of the excretory tubes of these glands. Each duct is garnished with a small hair planted close to its orifice.—

Between the caruncula lachrymalis and the cornea, the tunica conjunctiva, in many persons, forms a plait or fold, which is very obvious when the eye is directed inwards; this has some analogy with the membrana nictitans, or third eyelid of certain animals, and has been called the *Valvula Semilunaris;* its principal use appears to be, to give increased facility of motion to the globe in an outward direction, from the looseness of its connexions between the lids and the ball.

The muscles of the eye, described at page 276, &c., are to be ranked among the auxiliary appurtenances of that organ.

[At the internal corner of the eyelids is a small muscle which I had occasion to observe for the first time in the winter of 1821–2. It has, I believe, escaped the notice of other anatomists till the present time. This muscle is about three lines broad

and six lines long, and arises from the posterior flat surface of the os unguis near its junction with the os ethmoides, and passes forwards and outwards, lying on the posterior face of the lachrymal ducts. As it approaches the junction of the lids, it splits into two parts, nearly equal, each of which is appropriated to a duct, and inserted along its course almost to the punctum lachrymale.

To get a distinct view of it, the eyelids must be separated from the eye and turned over the nose, leaving the tendinous attachment of the orbicularis and ciliaris muscles. The semilunar valve is brought into sight by this process, which must be dissected away, and also the fat and cellular membrane beneath it. The muscle is now seen, and by passing bristles through the lachrymal ducts its connexion with them is rendered evident, at the same time that we get a good idea of its size, origin and insertion.

While making this inspection, by turning the muscle a little aside, we shall be convinced of another fact of some importance, and which is equally neglected by most anatomists. It is, that behind the tendon of the orbicularis muscle a ligamentous matter passes from the corners of the eyelids to the flat part of the os unguis, which ligament would keep the corner of the eyelids from being deformed, notwithstanding the tendon of the orbicularis be cut through in the treatment of fistula lachrymalis. The lachrymal ducts are included in this ligament, and pass through it into the sac instead of going along the edges of the eyelids, as is commonly asserted.

This muscle appears to be intended to keep the puncta in contact with the ball of the eye. Dr. Physick has suggested, that it will also keep the edges of the eyelids applied to the eyeball in cases of extreme emaciation where the eye is much sunk. While investigating this subject, my attention was called by Dr. Harlan to a motion prevailing in the puncta lachrymalia, with which I was before unacquainted. The puncta project themselves and retract much after the manner of an earth worm, and it is probable that the latter motion may be produced in some measure by this muscle.

In consideration of some of the functions of this muscle, I have ventured to propose that it be called *Tensor Tarsi.*]*

The tendons of the four recti muscles, being spread upon the anterior part of the ball of the eye, constitute a partial covering, which has been called *Tunica Albuginea.*† This tendinous expansion does not extend to the edge of the cornea, but stops short of it by several lines.‡

Of the Ball of the Eye.

The spherical figure of the eyeball depends upon a strong and firm external coat called the *Sclerotica;* which has an aperture in its anterior part, filled up with a transparent substance, denominated *Cornea,* that closes it perfectly.

—The antero-posterior diameter of the globe of the eye, is greater than the transverse. The former is about ten or twelve lines, the latter about one line less. This difference is owing to the projection of the cornea, it being a section of a lesser sphere. A *Transverse* vertical section of the globe, taken at any part, will represent a perfect circle. In short-sighted persons, the antero-posterior diameter of the eye is greater still, relatively to the transverse. A similar difference exists between the eyes of young and old persons, and which accounts in part for the change which time effects in the power of vision. The axis of the globe of the eye does not correspond with the axis of the orbit; but is exactly parallel with that of the ball of the opposite side, except in cases of obliquity or squinting. The optic nerves running out in the direction of the axis of the orbits, must therefore reach the balls of the eyes, on the inner side of their axis.

—The sclerotic coat forms about five-sixths of the globe of the eye. The cornea the remaining sixth.—

* For a more full account of this muscle, see Horner's Anatomy.

† This is no longer considered as a proper membrane; it is inseparably connected with and forms a part of the sclerotic coat. The partial expansion of these tendons seen through the conjunctiva, gives a brilliant glistening appearance to the eye, from which is derived the common term, *white* of the eye; sometimes it is spoken of as the *Adnata.*—P.

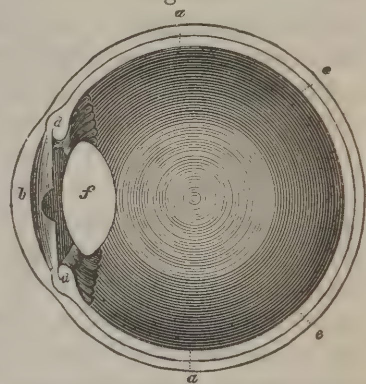
‡ By line, is meant one-twelfth of an inch.

The sclerotica is lined by a thin and delicate membrane, the *Choroides*, which is in close contact with it, but does not extend over the whole internal surface of the eye, and is deficient in the whole of the part occupied by the cornea.

On the internal surface of the choroides is spread the pulpy expansion of the optic nerve, called the *Retina;* the natural consistence of which is not much more firm than mucus.

Within these coats is a cavity that corresponds with the figure of the sclerotica and cornea, but is divided by an incomplete membranous partition that separates the anterior part of it, which is covered by the cornea, from the remainder. This partition is called *Iris;* and it has a circular vacuity in the centre, directly opposite to the middle of the cornea, which is denominated the *Pupil.* Rays of light, which penetrate the transparent cornea, pass through the pupil into the posterior part of the eye.

Fig. 74*.



The eye, thus formed, is filled with several transparent substances, called *Humours.* The greatest part of the cavity, posterior to the iris, is occupied by the vitreous humour, which is thus denominated, from its apparent resemblance to melted glass.

In front of the vitreous humour, and directly behind the pupil, is a small body, with double convex surfaces, called the *Crystalline Lens.*

* Fig. 74 is a magnified representation of a vertical section of the eyeball, showing the arrangement of the exterior tunics. *a*, Sclerotic coat. *b*, Cornea. *e*, *e*, Inner surface of the choroid coat. *d*, Ciliary ligament, and on its inner face, the ciliary body and processes. *f*, Lens, in front of which is the aqueous chamber, divided into two parts by the iris, which is seen stretched across it, with a semicircular hole in it, which is a section of the pupil. Fig. 79, exhibiting the retina and hyaloid tunics, to which the lens also is added, may be considered as removed from the interior of the choroid coat of this figure.—P.

In the space between the lens and cornea is a thin fluid, denominated, from its consistency, the *Aqueous Humour*.

Several of the parts, above enumerated, have exquisite delicacy of structure, and require a very minute description.

Of the Tunica Sclerotica.

The *Tunica Sclerotica*, or external coat of the ball of the eye, derives its name from a Greek word, which signifies to make hard. It is composed of opaque white fibres, of great firmness, which form a membrane of very close texture, that supports the globular figure of the eye. It is thicker behind than it is before; but the expansion of the tendons of the recti muscles gives it a partial additional covering. —At its thickest part, just at the outer side of the optic nerve, the sclerotica, is a line and a half thick. Immediately behind the insertion of the recti muscles, about half a line. The latter is the weakest part of the parietes of the eye-ball, and a blow applied upon the cornea will cause a rupture at that part, rather than at any other.—

It has been considered, by many anatomists, as continued into the cornea; but it can be separated from it by putrefaction; and it is essentially different from it in structure.

The aperture in it, which is occupied by the cornea, is not perfectly circular, but inclines somewhat to the oval form, the transverse diameter being rather longer than the vertical.

Posteriorly, it is intimately connected with the optic nerve, which enters it, not directly at the extremity of the axis that passes through the centre of the cornea and pupil, but on the inside of this spot.

The optic nerve has a firm coat (neurilema) which invests it rather loosely; this coat seems to be continued into, or expanded upon the sclerotica. Within it, the delicate nerve diminishes considerably before it perforates the sclerotica, and appears to be composed of fibres. At the small place of its penetration, the sclerotica is very thin; and it seems that the nerve does not penetrate through one aperture, but these fibres pass separately through very small foramina, in this thin part. The foramina are necessarily very small, as the diameter of the whole perforated portion

in some eyes, does not exceed two lines, or one-sixth of an inch.*

The sclerotica, in its natural state, has few, if any, vessels, that carry red blood. The great vascularity, which is so evident in ophthalmia, is in the tunica conjunctiva.

—It is perforated posteriorly immediately around the optic nerve, with a great number of oblique foramina, through which the ciliary arteries and nerves enter. A little in front of these are seen other orifices, by which the veins emerge from the interior; and near its junction with the cornea, a few are met with, which allow of the entry and exit of vessels, directly upon the iris. These latter vessels become very apparent in iritis, but present a hue less intensely bright, than those more superficial, which are involved in simple conjunctivitis.—

The Cornea.

The transparent membrane which fills up the vacuity in the anterior part of the sclerotica, is denominated *Cornea*, from its resemblance to horn.† It is said to be superior in strength to the sclerotica; and it is also very firm. It is formed of lamina, that

* We find one or two of these larger than the rest, for the transmission of the central artery and vein of the retina. The space occupied by these foramina, is called the *lamina cribrosæ*, or sieve-like plate of the sclerotica. The optic nerve is made up of bundles of medullary filaments, each of which is enclosed in a minute envelope of cellular tissue, which is a process reflected inwards from the general neurilema of the nerve. By opening the eye, and removing all the coats but the sclerotic, and then squeezing slightly and pressing forward the nerve, in the direction of the ball, the medullary matter will be seen to exude through the foramina of the cribriform plate.—P.

† The neurilema of the optic nerve which is an emanation from the dura mater of the brain, is lost upon the sclerotic tunic. Hence, Galen, and many writers since him, even Zinn and Meckel, consider the sclerotic coat as derived from the dura mater. Many have also described the choroid as derived from the pia mater. It is better, however, to adopt the opinion of Albinus, Winslow, and others, that these coats are peculiar and expressly adapted to the eye, and that the sheath of the optic nerve, is continuous with the sclerotic without abruptness, by a sort of insensible change, always seen when one membrane terminates in another. This theory of formation, besides, is not borne out by comparative anatomy; for in scaly fish, where the dura mater is membranous, the sclerotica, is corneous or bony.—P.

are separable from each other, which are supposed to be connected by a very delicate cellular membrane.

This cellular membrane appears sometimes to contain a fluid; for, if a section be made of the coats of the eye, and pressure be applied to the cornea, an exudation will be perceived, both upon its internal and external surfaces.

—The cornea is composed of six or seven distinct lamella, laying over each other, like the leaves of a book, and which may readily be separated by maceration. The cellular tissue which connects them is so loose as to enable us to slide the layers slightly over one another between the thumb and finger. The cells of this tissue are filled with a fluid; hence it has been called by some writers, *substantia spongiosa corneæ.* This fluid performs the important office, of preserving the transparency of the cornea, by equably distending the cells, which may be proved by a simple experiment, viz. by forcing the fluid by pressure from a part of a recent cornea, when that part becomes opaque, but has its transparency restored by the return of the fluid, on the removal of the pressure. In old persons the cornea becomes denser in its structure, and often presents an opaque ring at its circumference, called *Arcus Senilis.*—

The cornea is covered by the tunica conjunctiva, which adheres firmly to it, but may be separated after maceration. It can also be separated from the sclerotica after maceration, and a slight degree of putrefaction, especially if the parts, when in this situation, are suspended a short time in boiling water.

The cornea is lined internally by a fine membrane, called the *Capsule* of the aqueous humour; which will be evident if the coats of the eye are boiled. In this case, the cornea hardens, and the capsule of the aqueous humour appears detached from it, like the cuticle raised by vesication.

In a sound state, the sensibility of the cornea varies considerably.* The vessels in its structure do not carry red blood;

* It is the opinion of Dr. Physick, whose numerous and successful operations on the eye have afforded him many opportunities of judging, that the incision of the cornea always occasions some pain, which is very different, as to its intensity, in different persons.

it is, however, much changed in its structure by inflammation; and it is said that blood has been found between its lamina, in consequence of violent strokes upon the eye.

It is the segment of a smaller sphere than the sclerotica; and therefore is more convex. The degree of convexity is very different in different persons; those in whom it is very great are necessarily short-sighted. It is not perfectly circular, but rather oval: the transverse diameter being the longest.

The cornea and sclerotica are connected to each other by sloping surfaces. The edge of the sclerotica projects over the internal lamen of the cornea, and the edge of the cornea passes under the external surface of the sclerotica.

The separation above mentioned proves the cornea and sclerotica to be distinct from each other. And although their structure is essentially different in the human species, it is much more so in some fishes and in some birds.

—The cornea is about six lines in its longest or transverse diameter, and is a section of a spheroid, the diameter of which would be seven lines and a half.

—Its thickness is nearly equal throughout; about a line and a half. Mr. Ramsden and Sir E. Home assert, that it is rather thickest in the centre. On the inner face of the cornea, at its junction with the sclerotica, there is a slight groove, where the iris meets the ciliary ligament and is attached in contact with it. According to Professors Knox, Cloquet, and Jurine, the most internal layer of the cornea is united to the iris by short fibres, which have something of a tendinous appearance, and by which they think the contraction of the iris, augments the convexity of the cornea.* Ramsden and Home, assert that the tendons of the recti muscles are inserted into the layers, or rather expanded

* Professor Jacob considers this internal layer of the cornea, (placed immediately in front of the aqueous humour,) as a peculiar layer of semicartilaginous matter, like the capsule of the lens; the office of which is to preserve the proper curve of the cornea, and which he has named the *elastic cornea*. He considers it as terminating behind, by slipping in between the ciliary ligament and sclerotica. It is this membrane, he thinks, which forms the protruding pouch in ulcerations of the cornea. Dissections made in the manner he recommends, have not as yet proved to me, satisfactorily, its existence.—P.

over the surface of the cornea; by the action of which the cornea may be flattened. This, however, is but a revival of the opinion of Morgagni and Briggs, which Zinn endeavoured to refute.—

From what has been already stated, it appears that there are pores in the cornea, through which the fluid situated between its lamina may be pressed.

It is probable that an exudation through these pores takes place after death, as a pellicle then forms on the cornea, which, upon examination, appears to originate from the drying of a fluid effused there. This has been considered as a proof of death; but there are few practical physicans who have not seen a similar pellicle, during life, in persons who were very weak.

The Choroid Coat.

The sclerotica and cornea compose a firm external shell for the eye; upon which its form depends.

The sclerotica is lined by a thin, flexible, very vascular membrane, denominated *Choroides;* which is in contact with it nearly throughout its whole extent.

The choroides has been supposed to be derived from the pia mater; but this sentiment is not confirmed by observation; for the pia mater appears to be connected with the interior surface of the sclerotic coat.

It is so delicate a membrane, and so vascular, that it has been considered by some anatomists as a texture composed entirely of vessels and nerves.

It has three sets of arteries, which are derived from the ophthalmic branch of the internal carotid, viz.

1st. *The long ciliary arteries*, which are generally two in number: they penetrate the sclerotic coat at the posterior part of the eye, and pass, one on each side of the external surface of the choroides, dividing at the ciliary circle, each into two branches, which inosculate with each other around the great circumference of the iris.

—One of the long ciliary arteries (*internal inferior*) passes on the inner side, just below the horizontal diameter. The other (*superior external*) passes just above this diameter, on the outer

side. It is to avoid this vessel that, in operation for cataract, the needle is introduced a little below the horizontal level of the eye. The only arteries which are attended by veins, are the two long ciliary. These ciliary veins originate in the iris. The blood which is conveyed by the short ciliary arteries is returned, wholly by the venæ vorticosæ.—

Fig. 75.*

2d. *The short ciliary arteries*, which are very numerous: they penetrate the sclerotic coat near the optic nerve, are spread upon the choroides, and anastomose very frequently with each other: in their progress forwards they penetrate from the external to the internal surface of the choroides, and supply the iris and ciliary processes.

—These are about twenty in number, where they perforate the sclerotica, but originate from the opthalmic as three or four separate branches.—

3d. *The anterior ciliary arteries*, which are not very numerous, penetrate the sclerotic coat no great way behind the cornea. These are distributed among the branches of the long ciliary arteries on the iris.

The veins of the choroides are very peculiar: besides those which accompany the arteries above described, there are several veins which are situated more internally than the arteries and nerves, and about the middle of the eye: their branches are not arranged in the usual manner, but run from the main trunk, nearly in a semicircular curve, are almost parallel to each other, and very numerous; from this arrangement of their branches, they are called the *Vasa Vorticosa.*

—There are, according to Zinn, four or five of these larger trunks, the branches of which are vorticose, or thrown into

* Fig 75 is a representation of the vessels of the choroid coat and iris. The long ciliary artery and vein are seen running straight to the iris in front. The vasa vorticosa are seen upon either side. The short ciliary arteries are not seen in this figure.—P.

whirls, so as to admit of their arising from the whole surface of the choroid, in front, and behind, as well as upon the side of the trunks.

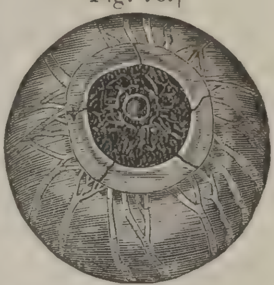
—This arrangement, has an arborescent appearance, and has been compared to the weeping willow. The vorticose vessels, being compared to the graceful pendent branches of the tree.

—These veins as well as the long ciliary, discharge finally at the back part of the eye into the ophthalmic veins or sinuses.*

—The arteries that run to the ball are very flexuous and anastomosing, so that the impetus of the heart may be overcome, and the retina undisturbed by the pulsation of any of the vessels. The great vascularity of the choroid appears to be for the purpose of secreting the pigment in abundance, so as to absorb the rays of light that enter from the pupil, and cut off those that penetrate on the side of the semi-opaque sclerotic coat.—

The nerves which appear on the choroides, come from the ophthalmic ganglion: they pass very obliquely through the sclerotica, and run forwards; having a very flat appearance in proportion to their size: five or six of them are of this description; some others are very small. There are some filaments which come from the nasal nerve, without passing through the ganglion.

Fig. 76.†



The internal surface of this coat is covered with a black paste, denominated *Pigmentum Nigrum*. This appears to be spread most thickly on the anterior part of it, and thinner behind, near the optic nerve; it is said to be thinner and less dark in old persons. It seems to resemble the matter of the rete mucosum of negroes, when that is softened by putrefaction. It is asserted that the colour of this pigment has never been changed by the ordinary chemical agents, or by moderate heat. When it is washed away, the internal surface of the choroides appears to be villous.*

* Zinn, Dé vasis Subtilior Oculi, 1790.—P.

† A representation of the nerves of the choroid coat and the iris.—P.

There is also a portion of this substance on the external surface of the choroides. It is said that in very recent subjects, this matter appears to be inherent in the structure of the internal surface, and does not come off when it is rubbed gently; or even when immersed in water; but it is certain, that a considerable quantity of it sometimes appears on the exterior surface of the choroides, in eyes that are not very recent.

—According to some experiments recently made by M. Mondini, and Professor Lavini, the dark-brown colour of this pigment, is owing to carbon and oxide of iron; after incineration, particles of iron were readily attracted from the remains by the magnet.*

—In the eyes of many animals, nearly all the ruminantia, the horse, the cetacea, most of the carnivora, and some cartilaginous fishes, the choroid presents at its back and lower part, a beautiful brilliant membranous appearance, which is called the *tapetum lucidum*, from its power of reflection. It supplies the place of pigment; for underneath it the pigment is nearly or quite deficient. Its colour varies in different animals from greenish blue, to yellow, and silvery white.

—The rays of light in these animals, will therefore make a double impression upon the retina, as they pass through it to the choroid and outwards again by reflection. In man this *tapetum* does not exist, though the term is sometimes applied to the inner surface of the choroid. According to Dalrymple, the membrane of Jacob, is a double reflected serous membrane, one reflection of which is spread smoothly over the inner surface of the choroid in most animals, and seems to confine the pigment and prevent its staining the retina, and which, in maceration, breaks up and carries off the pigment in shreds. This appears to be the same membrane described by Mondini, (*Membrana Mondini*,) as a magnificent and delicate net-work, with meshes so fine as to prevent the passage of a single globule of the pigment to sully in the least degree the delicate retina. Ruysch gave a description of a membrane, since called the *Membrana Ruyschiana*, in

* Anatomy of the Eye by J. Dalrymple, London, 1836.

which he asserted that he had raised the inner vascular layer at the back part of the choroid where the final ramifications of the vessels take place, as a separate membrane: anatomists now generally consider this separation to have been artificial, and that the choroid is a simple vascular nervous membrane.—

The celebrated Ruysch, and many anatomists after him, have considered the choroides as composed of two lamina; but it seems to be the opinion of the anatomists of the present day, that it consists of but one membrane; and there are some who consider it as a mere tissue of vessels.

In the white rabbit, and some other animals, the pigmentum nigrum is entirely deficient; and the pupil of the eye appears of a red colour, owing to the blood-vessels of the choroides.*

The general complexion between the choroides and sclerotica is very slight; depending upon a fine cellular substance, and very small blood-vessels and nerves.

But immediately around the margin of the cornea, the choroides and sclerotica are firmly connected to each other, by the intervention of a portion of cellular substance, which although soft, is dense and compact, and of some thickness. As this substance extends round the circumference of the cornea, it necessarily forms a ring; which is between one and two lines broad. This substance, thus placed, constitutes the *Ciliary ligament;* which has, to the great perplexity of students, been called by many different names; as *Orbicularis Ciliaris, Annulus gangliformis,* &c.†

It is very distinguishable from the choroides, the sclerotica, and the iris; and appears generally of a gray colour; but contains the ciliary nerves and arteries, in great numbers, as they pass to the iris.

In this circular band is a small canal, discovered by the Abbé Fontana, which is moistened by a pellucid fluid; but its use is not known.‡

* Its deficiency is also observed in individuals of the human race, called Albinoes or leucœthcopics.—P.

* Discovered by Fallopius in 1584.

† See Fontana on the Poison of the Viper, vol. 2, page 310; and also Adolph Murray, Nova Acta Upsal, vol. 3.

All the choroides, which is posterior to the ciliary ligament, is in close contact with the internal surface of the sclerotica; but the choroides continues anterior to the ligament; and this anterior portion takes a different position. It no longer lines the internal surface of the shell of the eye; but is reflected inwards; and takes a transverse direction, as if it were to form a partition. This reflected part forms the *ciliary body*, and the *ciliary processes*, which will soon be described.

The choroides begins to take this reflection inwards, at the place where it is connected with the ciliary ligament. Immediately anterior to the ligament, the cornea is continued from the sclerotica, and, being more convex than the sclerotica, it projects externally and anteriorly. As the ciliary ligament is situated between the sclerotica and choroides, very near to the place where the sclerotica unites to the cornea, and where the choroides is reflected internally to form the ciliary processes, the edge of the ciliary ligament must lie in the angle formed by the cornea, which is anterior and external, and the reflection of the choroides, which is internal. To this edge of the ciliary ligament is fixed the circumference of the circular membrane, called *Iris*, which is now to be described.

The Iris

Is a flat membrane, which does not partake of the spherical figure of the sclerotica and cornea, or of the choroides, but extends across a portion of the cavity of the eye, and forms a septum. As it is circumscribed by the ciliary ligament, it is necessarily circular. It has a round foramen near its centre, which is called the *Pupil*, which, in the healthy subject, varies continually in size, according to the degree of light to which the eye is exposed.*

The situation of the iris in the cavity of the eye is such, that, at its circumference, it is nearly in contact with the circumference of the cornea; it is actually in contact with the anterior

* The iris is rather narrower next the nose, than on the side of the temple, by which reason, the pupil is not exactly in the centre, as first stated by Winslow in 1711.—P.

edge of the ciliary ligament, and with the anterior surface of that part of the tunica choroides, which is reflected inwards, and forms the ciliary processes.

As the iris is flat or plane, and the cornea is the segment of a sphere, there must be a considerable vacuity between them. This vacuity constitutes the anterior chamber of the eye.

The iris, therefore, is a septum, passing across the eye at its anterior part, and separating that portion of the cavity, which is bounded exteriorly by the cornea, from the larger portion formed by the sclerotica.

The anterior, or external surface of this membrane, is very remarkable for its colour; in persons of a light complexion it is generally of a light blue, intermixed with white; or of a gray, or light hazel, &c. In those whose complexions are dark, it is almost invariably dark also. These colours are so arranged, that frequently there is an appearance of lines, sometimes nearly radiated, more frequently curved in various directions, but tending from the circumference towards the pupil or centre; and when the general colour of the iris is blue, these lines are often whitish.

When this surface is examined in water with a magnifying glass, it appears to be covered with very fine villi, which probably have the effect of increasing its lustre.

From a supposed resemblance of these colours to those of the rainbow, the membrane has been called *Iris*, and is generally known by this name; but, unfortunately, another appellation has been given to its internal and posterior surface, which is covered with a black pigment like the choroides, and has been commonly called *Uvea*.*

This black pigment, on the internal or posterior surface of the iris, has been supposed to have a great effect in determining its general colour; and there is some reason for this opinion, as the

* So called from its colour, which is dark brown, resembling the skin of a raisin. The inherent colour of the iris is either light blue or orange, which, with the pigment on its back part that varies in thickness and in intensity of die in different subjects, form all the variety of colours of the human eye.—P.

iris is partly transparent; but there is a colour inherent in it, which is most evident when the black pigment is very carefully washed away.*

Thus, the light hazel colour remains unchanged after the black pigment is removed; and it is not probable that light blue is much influenced by the black pigment.

The iris is capable of dilatation and contraction to a very considerable degree, by which the pupil, or central vacuity is enlarged or diminished. By this means it regulates the quantity of light admitted into the eye. Upon the first exposure to strong light, the pupil of every healthy person is observed to be diminished, and upon the diminution of light, to be enlarged.

It has been ascertained by experiment, that this motion of the iris is not excited by the action of light immediately upon it, but on the interior surface of the eye; and this circumstance has occasioned the greatest attention to the structure of this extraordinary and important membrane.

Anatomists of the greatest respectability hold opinions extremely different, indeed, respecting the structure of the iris. They agree that there are many radiated fibres on the posterior surface, commencing at its circumference, which can be readily seen when the black pigment is washed away; but while many respectable anatomists declare that they have not been able to see any circular fibres, Dr. Monro describes them minutely, and has published a plate of them. He considers them as forming a circle immediately round the pupil, which circle makes about one-fifth part of the breadth of the iris.†

In the human subject, the iris does not appear to be divisible

* Sometimes the pigment is strewed here and there in patches, thicker than in other parts, which gives a marbled appearance to the iris. The pigment, which, like that of the choroid coat, is a secretion from the vessels of the part, is confined by having reflected over it, the serous membrane of the posterior chamber of the eye.—P.

† See his publication, entitled Three Treatises: On the Brain, the Eye, and the Ear.

into lamina.* It is abundantly supplied with arteries, which form two circles upon it, and it has also a large supply of nerves.

The operations of the iris, in contracting the pupil, upon exposure to light, and dilating it, when light is diminished or withdrawn, have been explained very differently by persons who have different sentiments respecting its structure. Some of those persons, who do not believe in the existence of muscular fibres in the iris, suppose its motions to depend upon the sudden turgescence or depletion of its blood-vessels: while others impute it to a peculiar quality, exclusively enjoyed by this membrane.

Dr. Monro, who refers the contraction of the pupil to the action of the circular fibres, which is excited by the stimulus of light applied to the retina, considers this operation as analogous to that of the abdominal muscles, in those cases of coughing, which are produced by irritation of the glottis. The action of the muscles, in these instances, being excited by substances applied to the glottis, which would have produced no irritation if they had been applied to the muscles themselves.

The dilatation of the pupil appears, in the human species, if not in other animals, to depend upon a different cause. It seems to be a passive state of the eye, which takes place when the stimulus is withdrawn, and the consequent action ceases. There is some elasticity in the iris; and a great many, perhaps all, of its *natural or healthy* motions in the *human species*, may be explained by the contraction of the circular fibres, induced by irritation: and by the contraction of the rest of the membrane in consequence of its elasticity; which always exhibits its effects when the muscular action ceases.

—It is a question yet undecided, whether the contraction and dilatation of the pupil is dependent upon an involuntary sphincter muscle, placed at the pupillary margin, and a series of longitudinal or radiated fibres, running from the greater to the lesser

* According to H. Cloquet, the iris consists of two lamina, intimately united near the pupil, but separable towards the greatest circumference. It is, besides, lined, in front and behind with the transparent serous membrane of the aqueous chambers.—P.

circumference of the iris, as asserted by Monro, and more recently still, by Professor Maunoir and others, or whether it is simply an erectile tissue, dependent in its contraction upon a rush of blood, under the influence of some stimulation, into its serpentine vessels. Anatomists of nearly equal reputation, advocate these opposite theories. Small doses of belladonna, stramonium, or opium, dilate the pupil; larger and poisonous doses, contract it. The motions of the iris, contracting to diminish the quantity of light admitted, when the rays excite too intense an impression on the retina, and dilating to receive more when they are feeble, appear, in many respects, like muscular action, and have been compared to the heart, dilating to receive blood, and contracting to expel it. Professor Jacob, of Dublin,* describes the circular muscle as very visible, in some quadrupeds, after the pigment has been removed, on the back surface of the iris, near the pupillary margin, and is about the twentieth part of an inch in diameter. The longitudinal or dilating fibres, he has described on the front of the iris, as consisting of irregular shaped masses, placed in the middle space between the greater circumference and the pupil, sending forward a number of little elevated lines or tendons which terminate in loops about the twentieth part of an inch from the pupil, and from these loops smaller striæ converge to the edge of the central opening. The whole arrangement, he says, is like that of the *columnæ carneæ* and *chordæ tendineæ* of the heart. The examination of a hazel eye, in a living subject, or of an iris, under water, seems

Fig. 77.†

* Medico-Chirurgical Transactions.

† Fig. 77, is a very accurate representation, according to Professor Jacob, of the face of the iris, showing the columnæ carneæ and chordæ tendineæ much magnified. The posterior surface of the iris presents a very different appearance.—P.

in favour of his views. The iris is extremely vascular, and receives its blood partly from the long, and partly from the anterior ciliary arteries.
—They anastomose with each other, so as to form the greater arterial circle round the outer margin of the iris, and then run out in a serpentine course and form a lesser circle near the pupillary margin. From this lesser circle, innumerable minute vessels radiate toward the centre, and abruptly terminate at the edge of the pupil. When the pupil is contracted to its minimum size, these vessels become straight. The veins are also abundant; some terminate in the long ciliary veins, and some in the vasa vorticosa.
—With nerves also, the iris is richly furnished, probably more abundantly than any other tissue of equal size in the whole economy. It is supplied from the ciliary nerves, which run out between the choroid and sclerotica, in the form of flattened cords, after they have perforated obliquely the latter tunic.
—They inosculate with each other frequently in the greater arterial circle of the iris, and appear under the microscope to form little knots or ganglia; the branches which they send inwards towards the pupil, may be seen in some of the larger quadrupeds to inosculate with each other, but cannot be traced satisfactorily on account of their faint appearance and pulpy character.—

The elastic power in this case may have some analogy to the elasticity of the arteries, which certainly produces some of the contraction of those vessels; but there is another principle of contraction superadded to this, which produces effects different from those of mere elasticity.*

In the fœtus, prior to the seventh month after conception, the pupil is closed by a delicate vascular membrane, called the *Membrana Pupillaris;* which, after this period, completely disappears.†

—The membrana pupillaris as shown, by W. Hunter and J.

* Some persons, like the late Dr. Wollaston, exercise a voluntary control over the movements of the iris, dilating or contracting it at will.—P.

† The discovery of the Membrana Pupillaris is claimed by Wachendorf, Prof.

Cloquet, consists of two layers, formed by an extension, back to back, of the serous lining membrane of the anterior and posterior aqueous chambers, across the pupil. This is ruptured, or effaced by a retraction of its vessels, to form the lesser arterial circle of the iris,* which is never seen till after the removal of the membrane. The lining membrane of the two chambers then form a continuous coat.—

The iris was formerly supposed to be a continuation of the choroid coat; but it is now generally agreed that it is a distinct membrane; for when the eye is very slightly affected by putrefaction, it can be pulled off, and the choroides left entire.

The choroides, on the contrary, cannot be separated from the ciliary processes without laceration; and when the pigment is washed away from its internal surface, it is very obvious that these processes are continued from the substance of the choroides and reflected inwards, so as form a projection into the cavity of the eye.

Of the Ciliary body, and the Ciliary Processes.

This internal projection forms a ring or a circle, which has the ciliary ligament before described, near its circumference, and anterior to it.†

It is so disposed, that the whole of its internal or posterior surface appears to be formed into radiated plaits, which extend

of Botany in the University of Utrecht; by John Hunter; by Haller; and by Albinus.

* The thickness of the iris, is considered three or four times as great as that of the choroid. When the pigment is carefully wiped away from the posterior surface of the iris, we see, according to H. Cloquet, a great number of straight, raised, and converging lines, which are confounded into a membranous zone near the pupil, and appear to be the continuation of the *ciliary* processes. Well marked villi are also seen on the posterior surface.—P.

† The ciliary ligament or circle, evidently serves as an attaching medium between the iris, cornea, and sclerotica. Its structure is not fully understood. Some modern anatomists, have considered it in the light of a nervous ganglion; others as composed of muscular fibres. *Vide*, Knox on the Muscularity of the Ciliary Ligament. Ed. Philos. Trans. vol. x.—P.

from the circumference to the central vacuity, where they terminate.

The whole of this structure, or the membrane thus plaited, is called the *ciliary body*, while the plaits are called the *ciliary processes.*

In a natural state of the eye, the ciliary body is covered with a large portion of the pigmentum nigrum. It may be seen very well by placing the eye on the cornea and removing the posterior part of all the coats, without deranging the humours. When thus viewed from behind, it has a black surface, and appears like a ring formed of radiated lines; it has been compared to a flower with radiated petals.

When the black paint is washed off, and the humours of the eye removed with proper caution, the plaited structure of these radiated processes will be very apparent; it then will appear that the membrane of the choroides is so arranged as to form radiated plaits, and that these plaits are the *ciliary processes.*

These plaits or processes do not lie upon each other, but are placed on their edges, one edge looking into the cavity of the eye, and the other edge anteriorly towards the iris.

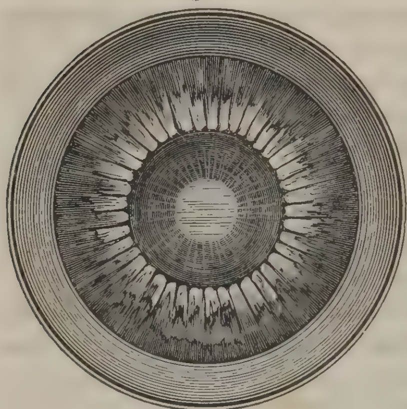
Each *ciliary process* seems to originate from two lines or smaller plaits, called the *ciliary striæ*, which soon unite and form it. The *process* or plait, thus formed, is rather larger at its central extremity than at any other part; and their central extremities are not of equal lengths, but alternately longer and shorter.

The ciliary processes do not extend to the centre of the circle of which they are radii, but stop short of it; and thus include a circular vacuity or aperture, which is larger than the pupil of the iris, and situated a little way within or behind it. This aperture is occupied by the crystalline lens (to be hereafter described); but the central extremities or terminations of the ciliary processes do not adhere to the lens, for they are loose and movable; but they are in contact with its anterior surface, near the margin.

It is, however, to be observed that the ciliary processes are loose only at their central extremities; for, towards their other extremities, they seem to adhere, anteriorly, to the iris; and,

posteriorly, to the retina, and to the capsule of the vitreous humour.

Fig. 78.



—The ciliary processes vary in number from 70 to 85. They are extremely vascular and when minutely injected and magnified, their vessels present the appearance of the nervures or vessels of a willow leaf. Their intimate structure and function are unknown. Home, Wallace* and others from their observations on the inferior animals, believe them to be muscular and to aid in adjusting the focal distance of the lens, to the capsule of which they are indirectly connected; drawing it backwards and forwards like a magnifying glass, with 80 strings attached to its margin.† Others, with equal reason have believed them to be erectile, altering the position of the lens by their expansion or contraction. The processes are not of equal length, each alternate one being shorter. Fishes with spherical lenses, according to Mr. Wallace, have no ciliary processes: The adjustment of the lens being in them effected by a single membrane or muscle attached at one point. The rolling of the lens, as it is drawn backwards, it being a *sphere*, can make no difference in regard to its functions.—

The ciliary body, (or the radiated ring formed by all the processes) is about two lines broad in the *human subject;* but the part next to the nose is rather narrower than the rest of it.

The black pigment is spread over the whole of the posterior,

* Structure of the Eye, by W. C. Wallace. New York, 1836.

† This figure from Zinn's work, represents the corpus ciliare or circle of ciliary processes in man, on a large scale. In the centre is seen the iris, with its pupillary opening. There is certainly no direct connexion, between the central extremities of the ciliary processes and the capsule of the lens.—P.

or internal surface, of the ciliary body; but it is much more abundant towards the circumference than towards the centre. It is also more abundant in the furrows between the ciliary processes than it is in the processes themselves; and as the membrane, of which the processes or plaits are formed, is of a whitish colour, the processes, at their central extremities, have a whitish cast.

The black pigment is also spread over the anterior surfaces of the processes; on all that part which is loose, and not in contact with the posterior surface of the iris.

When the pigment is completely washed away, the colour of the ciliary body appears grayish; but if the eye has been successfully injected, it will appear to be composed almost entirely of vessels; and to have a villous surface.

The Retina.

Within the tunica choroides, and in contact with its internal surface, is a third coat of the eye, the *Retina.* This coat is evidently derived from the optic nerve, although its texture appears somewhat different.

Before the optic nerve arrives at the ball of the eye, a small branch of the ophthalmic artery penetrates its coats; and when the nerve perforates the tunica sclerotica, as described in page 375, this artery passes with it.

On the internal surface of the choroides, the nerve forms a small prominence; and from this, the retina expands, with many ramifications of the aforesaid artery in it.

The retina has the appearance of mucus, and the semi-transparency of a surface of ground glass; but when immersed in water, it floats like a membrane.

By particular management, when the retina floats in water, a considerable quantity of the soft substance may be removed, and a delicate, soft, transparent, membranous substance, with the vessels, will remain.

The retina, therefore, seems to consist of a delicate, vascular, membranous web, with a medullary pulpy matter spread upon it, and supported by it.

Thus constituted, the retina extends from its origin, at the optic nerve, to the commencement of the ciliary processes.

It lines the choroid coat, and is, therefore, in contact with the pigmentum nigrum, on its internal surface, but it is simply in contact with it, and is not tinged by it. No vessels pass from it to the choroides; and, when a posterior section of the eye is made, it slips from it without any appearance of adhesion, being attached only to the optic nerve.

Most anatomists agree respecting these circumstances, but there is the greatest difference of opinion respecting the extent of the retina. Several distinguished anatomists, of the last century, thought very differently from each other on this subject; and two of the first anatomists of the present day have embraced opinions entirely opposite. Monro is convinced that it extends, under the ciliary processes, to the crystalline lens: and Sömmering asserts, positively, that it terminates at the commencement of the ciliary processes.* Some of the anatomists† of London, incline to the opinion embraced by Sömmering; and the late ingenious Bichat adopted the opinion embraced by Monro.

Both parties confide in their own observations, and refer to the eye. An object which appears so very different to different persons, who have good sight, cannot be very distinct. The pulpy substance of the retina appears to terminate at the commencement of the ciliary processes; but a membrane of a very different texture seems continued from it to the crystalline lens.

Although the eye and the retina have long been objects of anatomical attention, Professor Sömmering made an interesting discovery respecting it, so lately as the year 1791, viz. that, at the posterior part of the retina, in the axis of the eye, and, of course, a little exterior to the entrance of the optic nerve, there is a spot of a circular or oval figure, about one line, or rather more, in diameter, of a yellowish or saffron colour, which is brightest about the centre.

* This opinion of Sömmering, which was advocated by Zinn and Morgagni, and more recently by Meckel, is now generally admitted. By careful observation it may be seen terminating a short distance behind the ciliary body.—P.

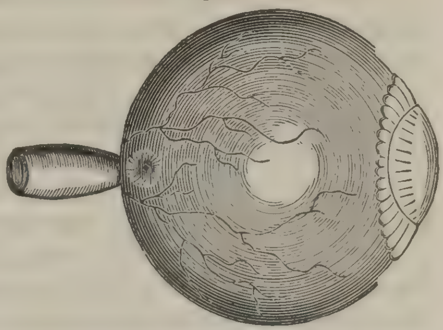
† See the new Cyclopædia, by Dr. Rees and others, article Eye.

In the centre of this spot is a round hole, equal in diameter to one-fourth of the spot. There are, generally, several small plaits of the retina about this place; one of these, which is very constant, extends from the optic nerve to this spot.

The colour of this spot is pale in children, bright in young persons of mature age, and pale at an advanced period of life.

The foramen is to be found in the fœtus, but not the yellow spot. The colour of the spot diminishes when vision is obstructed; and the spot disappears when vision is lost.

Fig. 79.*



There is the greatest reason to believe that the retina is the seat of vision; but it has been ascertained, most decisively, that the extremity of the optic nerve, from which the retina originates, is insensible to the rays of light. —Professor Knox of Edinburgh, and J. Dalrymple, from many careful observations made upon the subject, consider the folds of Sö nmering, as entirely a post mortem appearance, dependent on a collapsing of the retina, consequent to the escape of the fluids, through the cornea, which takes place speedily after death. This corresponds with my own observation, made upon the eye of a convict within three hours after execution, in company with Dr. J. K. Mitchell of this city, and the late Dr. J. P. Hopkinson. In this case the yellow spot of Sömmering was very manifest, and about two lines in diameter; but the surface of the retina was perfectly plain, and the

* Fig. 79 represents the retina, to which the optic nerve is attached behind, expanded in the form of an incomplete sphere over the hyaloid membrane of the vitreous humour, and terminating in front a short distance from the lens. The lens is seen lodged with its capsule, in a depression on the front of the vitreous humour, and surrounded by a series of delicate folds, (zona ciliaris,) which correspond with the ciliary folds of the choroid, (see Fig. 78.) The spot of Sömmering is seen near the entrance of the optic nerve.—P.

foramen appeared to be but a superficial depression, the size of a small pin's head, with a slightly elevated brilliant yellow margin. Dalrymple observed in one case the surface of the retina, perfectly smooth, and as the fluid escaped, the circular edges of the cup-like depression, (which he with Meckel and others, consider the foramen of Sömmering merely to be,) were elongated, elevated, and finally came in contact, forming the fold of Sömmering.

—According to Ammon, who has written a work, *ex-professo*, upon the yellow spot of Sömmering, there is never at any period of life to be found the foramen of which Sömmering speaks. The depression on the surface of the retina, and the appearance of a foramen are owing to the more intimate union at this point, of the choroid and retina by the intermedium of vessels. The yellow spot, according to him, is very vascular, and is usually apparent fourteen or fifteen months after birth, and is always to be found in the healthy adult eye. He has twice sought for it in vain, in cases of amaurosis, and once in congenital cataract. In the early periods of fœtal life, the choroid is red, and contains no black pigment.

—After the pigment is deposited, and toward the period of birth, its colour in the axis of the eye, where the yellow spot is to appear, is of a lighter brown than in other parts. As the spot begins to make its appearance fourteen or fifteen months after birth, the yellowness is first obvious on the outer side of the retina, next to the choroid, and he believes is entirely dependent on the action of light upon the retinal surface of the choroid pigment.

—The pigment, diluted with water, and exposed to the action of the rays of the sun, he says assumed a yellowish appearance. Inflammation of the eye, he asserts may produce the same change, as seen especially in the uvea, in inflammation of the iris, around the pupillary margin, where is formed the brown circle of which Lawrence speaks.* In the early state of developement of the fœtal eye, be found the sclerotica and choroid protuberant inward, opposite the place where is subsequently formed the yellow spot, and at which spot penetrate some of the ciliary arteries that subsequently branch from thence into the retina. The appearance

* *Vide* Lawrence, on the Venereal Diseases of the Eye.

of the black spot or foramen of Sömmering, he believes to be caused by a rupture of the delicate retina at this point, bringing into view the black pigment on the face of the choroid. In its first stage of formation the retina appeared a transparent layer, readily separated both from the choroid and the optic nerve.

—The use of the yellow spot, which he considers the most sensitive part of the eye, is to give a common axis to the organ, and stability during the exercise of vision. Hence the vacillation of the balls, and occasional squinting common to young infants prior to the formation of the yellow spot, as well as the rolling of the balls, in congenital cataract.

—"Centrum retinæ, in quo macula flava occurrit, præ caeteris ejus partibus lucis assimilationi optum esse videtur; necessario inde sequitior, puncretinæ locum imprimis lucis radiis offici et quasi detineri, non potest igitur non uterque oculus uno eodumque dirigi motu, et uno quasi stabiliri axe. Normalis autem haec oculi conditioni tunc desideratur, cum macula lutea nondum formata est, sive cum suspicari licet, hujus organi genesin prohibatum, aut ejus œconomiam turbatum esse."

—It is from this part, also, he thinks, originate those various expressions of the eye indicative of certain states of mind, as pity, hatred, love, sadness, etc.; while from the eyes of animals, especially those with the tapetum, there is emitted only the corruscations, indicative of rage.*

—In the human eye, the external medullary pulpy layer of the retina, when beaten up, presents all the appearance of central matter, as was observed by Galen. The nervous matter is, however, arranged in the form of fibres, agreeably to the recent microscopical observations of Langenbeck and Treviranus. According to the latter, when the optic nerve has penetrated through the sclerotic and choroid to the retina, its cylinders or nervous tubes spread themselves out on every side, either singly or collectively, into bundles; each cylinder, or collection of tubes bending inwards through the vascular layer, and terminating in the form of a papilla on the surface of the vitreous humour. In the

* Fred. Aug. ab Ammon, de Genesi et usu maculæ luteæ, in retina oculi humani obviæ. Accedit tabulæ in aes incisa.—Vinariæ, 1830.

eye of the halibut, the fibrous structure of the retina appears very manifest.

—Considering the formation of the retina, as described by Ammon, its great sensibility to light, and the known insensibility of the optic nerve to that stimulus, if the rays fall on it in any part of its course without first impinging on the retina, the retina cannot be considered as a mere expansion of the optic nerve, any more than the nerves themselves can be considered as a mere expansion of the brain. The retina may be considered as a peculiar structure, for the purpose of receiving the impression of the rays of light; the nerve as the mere agent by which this impression is transmitted to the brain, where it becomes a sensation.

Vascularity of the Retina.

—It receives its supply of blood principally from the *arteria centralis retinæ* of Zinn, a branch of the ophthalmic, which enters the optic nerve a short distance from the ball, and passes through the central foramen in the cribriform plate of Albinus, *vide* p. 375.
—Its distribution is principally to the internal vascular layer of the retina, and in the healthy state contains only the white portion of the blood. The blood is returned in veins which terminate in a single trunk that passes out through the cribriform plate.—

[Within three or four years a membrane has been discovered by Mr. Jacobs, Demonstrator of Anatomy in Trinity College, Dublin, which is situated between the retina and the tunica choroidea. Its tenuity and delicacy are extreme. It is diaphanous and is thought by its discoverer to be a serous membrane. It extends from the optic nerve as far forwards as the retina goes, and adheres by a delicate filamentous structure to both the retina and the choroid coat, but much more firmly to the former. Mr. Jacobs asserts that this filamentous structure, by which it adheres to the other two coats, is vascular: as this assertion, however, is founded on a process of reasoning, and not on absolute demonstration, our assent may very properly be withheld from it till an injection is brought forward to prove the fact. This membrane is well marked also in the sheep, ox, horse, dog, and other domestic animals; indeed, in all the mammalia which he has had the opportunity of examining. It exists, also, in birds and fishes,

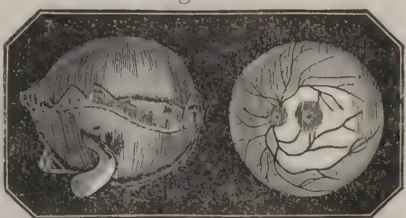
and is said to be particularly strong in the latter. M. Cuvier has described it in fish as one of the lamina of the retina, but its sensible properties are asserted by Mr. Jacobs to be very dissimilar to those of the retina.

As this membrane may possibly be confounded by the student with one of the lamina of the human retina, it should be borne in mind that the latter consists of two parts, a pulpy or nervous expansion and a reticulated vascular structure on which the pulp is laid, the pulpy part being external.

The reticulated structure is called by some the tunica vasculosa retinæ. Most anatomists have known and admitted these two membranes as composing the retina, yet but few have had the expertness to separate them from each other, and to leave at the same time the membranous structure visible. Albinus had the success to accomplish this separation; and I am informed, on the authority of Dr. Physick, that Mr. Hunter also succeeded in it.

When the common dissection of the retina is made and fixed in clear water, this membrane will be seen floating around it in delicate flocculi; but if a more careful dissection be made, by fixing the eye to the bottom of a basin of water, by its cornea, through the aid of shoemaker's wax, and the sclerotica and choriodea be removed from behind, this membrane may be turned down entire from the retina, with the end of the handle of a scalpel.]

Fig. 80.



—Fig. 80, represents on the left, the retina, with a portion of the optic nerve attached to it. The external membrane (*tunica Jacobi*) is turned down, and the foramen of Sömmering instead of a distinct hole, presents the appearance of a fold or depression with elevated sides. The figure to the right, shows the retina expanded over the vitreous humour, and the place may be observed from which the optic nerve has been cut away, and from which

the vessels branch out. To the left of this is seen the foramen of Sömmering, represented as a black spot, surrounded by a dark shade.—

Of the Humours of the Eye.

The three humours of the eye, viz. the *Aqueous*, the *Crystalline*, and the *Vitreous*, are separately invested with a membranous capsule, which is very delicate, and perfectly transparent.

The Vitreous Humour

Occupies almost all the cavity of the eye which is posterior to the iris. It of course possesses a spherical form. It has a depression in the centre of its anterior surface, in which the posterior surface of the crystalline lens is received. It is covered by the retina as far as the retina extends.

The peculiar consistence of this body, which resembles that of melted glass, is owing to its membrane; which is a spherical sac, divided by many septa, or partitions, that form small irregular cavities, in which a fluid is contained. This membranous sac is most perfectly transparent, and very flexible; it has, however, some strength; as it will support the weight of all the fluid it contains, and may be suspended from a hook or forceps. The fluid may be separated from the membranes, by beating the vitreous humour in a cup with a spoon; or by suspending the vitreous humour, and then puncturing it. In either case the fluid escapes; but the internal arrangement of the membranes is not visible.

It is said that when this body is frozen, the portions of fluid in the different cavities, have sometimes been distinguishable from each other, as distinct pieces of ice; and that their form is that of small wedges, with their edges directed to the crystalline lens as a centre, and their bases to the circumference of the vitreous humour. It is also said, that if this body be immersed in a solution of potash, the membranes will become opaque, while the fluid continues transparent; and that the appearance of the cells, thus exhibited, agrees with the form of the pieces of ice above mentioned.

This membrane is now generally called the *Tunica Hyaloidea*, from two Greek words which imply a resemblance to glass.*

Its particular structure is not perfectly understood. Vessels are not generally seen on it in the adult; but, in the fœtus, the artery in the optic nerve, (or the central artery,) sends a branch through the vitreous humour to the crystalline lens; and some branches of this artery are to be seen on the tunica hyaloidea.†

Throughout the greatest part of its extent, it appears to consist of but one lamen; but at the front part, near the ciliary processes, there are two lamina. The internal, or posterior, seems to be a portion of the proper tunica hyaloidea, and passes behind the crystalline lens. The external, or anterior, passes over and before the lens; or at least is attached to the anterior part of the capsule, in which the lens is contained. It is supposed, by some anatomists, that this membrane is continued completely over the crystalline lens; but it has not been separated.

As this lamen extends round the crystalline lens, it is in contact with the ciliary processes; or, with a production from the retina, which is supposed by some anatomists to pass between them. It is impressed with radiated plates by the ciliary processes, and some of the pigmentum nigrum of these processes adheres to it.

As these lamina of the tunica hyaloidea are separated by the crystalline lens, there is a vacuity between them, around the margin of the lens, and this vacuity must necessarily be circular in its course.

It is not probable that any considerable quantity of fluid is contained in this vacuity; for the two lamina concerned in its formation, appear in contact with each other. It can be readily demonstrated by puncturing the external lamen, and blowing into it through a small pipe. When thus distended, there appear

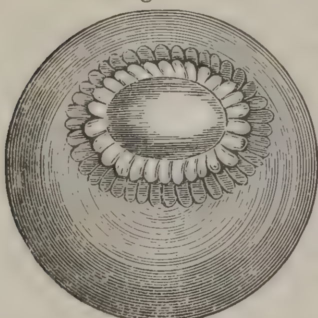
* Discovered by Fallopius in 1584.

† It is also believed that vessels pass from the ciliary processes of the choroid, to the ciliary folds (*zona ciliaris*) of the hyaloid tunic, between which the choroid processes are embedded. The hyaloid tunic must be very vascular, though usually containing only white blood, for in calves and sheep driven with blows to the shambles, the vitreous humour is often tinged with blood.—P.

to be incomplete partitions in the canal, or partial adhesions of the lamina forming it, which have the effect of partitions; these partitions are placed in a radiated direction, at some distance from each other, and give the canal a peculiar indented appearance. It is called by the name of the celebrated Petit who discovered it.

The anterior lamen of the tunica hyaloidea, which forms part of this canal, seems to adhere to the coats of the ciliary processes; for, if a section is made behind the ciliary ligament of all the coats of the eye, the vitreous humour will be found adhering to the anterior portion of the section, when it is lifted up.

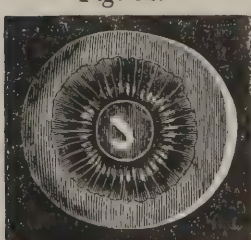
Fig. 81.



—Fig. 81, is an enlarged representation of the canal of Petit (called *godronnè*, from its resemblance to the puckers or ornaments of silver plate.) The lens is seen inclosed in its capsule, over which the anterior layer of the hyaloid is believed to pass. On the outer side is seen the canal of Petit; and on the outer side of this again, the corona, or zonula ciliaris of Camper and Zinn, stained by the pigment, and in the folds of which are placed the ciliary processes. The two bodies are thus, as it were, dovetailed together, and vessels, according to Dr. Knox, pass from the latter to the former.

—The *zona*, or *corona ciliaris* of Camper and Zinn, may be seen very distinctly by removing the sclerotica, choroid, iris, and retina, one or two days after death, leaving the vitreous humour entire, with the lens embedded in its anterior part. We then perceive a number of striæ on the vitreous humour, converging towards the lens, as seen in Fig. 82, corresponding in appearance with the ciliary bodies, and narrowed on the inner side exactly as the latter is. These appearances have been noticed by most writers, merely as the marks

Fig. 82.



left by the ciliary processes; but I have satisfied myself, by a careful microscopical examination of the eyes of different animals, in the method advised by Mr. Jacob, confirmatory of the opinions of Knox, Camper, and Zinn, that it has a real existence, and consists of folds of the vitreous humour, which commence behind by a well defined margin and terminate in front, by being attached to the capsule of the lens; the furrows between these folds being capable of receiving the folds of the ciliary bodies. By this means, these two bodies are firmly connected or dovetailed together, one of which (the *choroid*) has considerable strength and firmness, and the other (the hyaloid tunic) is extremely delicate in structure. By means of this connexion, the vitreous humour of the lens, through the medium of the ciliary ligament, becomes attached between the sclerotic coat and the iris, without which, the mechanical construction of the eye would have been imperfect.—*

When the fluid contained in the tunica hyaloidea is discharged and collected, it appears to resemble, in all its properties, the fluid in the anterior chamber of the eye; which, from its consistence, has been called the *Aqueous Humour.* This circumstance proves that the particular consistence of the vitreous humour is derived from the arrangement of its internal membranes.

The fluid, thus obtained, consists of water slightly impregnated; 1st, with albumen, 2dly, with gelatine, and 3dly, with muriate of soda.

The vitreous humour appears necessary, to give the ball of the eye the necessary size, for the performance of its optical functions; to keep the retina properly distended, and to retain the crystalline lens at the proper focal distance from the retina.

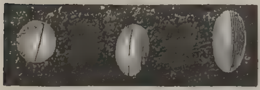
The Crystalline Lens

Is a solid body; although it is considered as one of the humours of the eye. It is of a softish consistence, and has been compared to gum half dissolved; but is more firm in the centre than about the circumference.

* *Vide* article Eye, in the Cyclopedia of Anatomy and Physiology, from which many of these figures have been taken.

When sound it is perfectly transparent in young and middle-aged persons; but is yellowish in old age. It is convex on both surfaces, but the convexity of the different surfaces is different. The anterior surface, which is the least convex, is the segment of a sphere, whose diameter varies from six to nine lines. The posterior surface, which is most convex, is the segment of a sphere, whose diameter varies from four lines and a half, to five lines and a half. This lens is most convex in young subjects.

Fig. 83.*



It is invested with a tunic of the same lenticular form with itself, which has some firmness; but in a healthy state, is also perfectly transparent. The lens either does not adhere at all to the tunic, or so slightly, that it projects from it with a very slight pressure, as in the operation of extracting the cataract.

The posterior surface of this tunic adheres firmly to the tunica hyaloidea, with which it is in contact: and this last membrane is generally ruptured in the atttempt to separate them, although the separation can sometimes be effected without rupture.

The anterior surface is so intimately connected with that lamen of the hyaloid tunic which passes before it from the canal of Petit, that it is not separable without laceration; and it, therefore, has not been ascertained, whether or not this lamen extends completely over the surface.

As the capsule of the lens is thus connected with the tunica hyaloidea, and this last mentioned tunic adheres to the ciliary body, it necessarily follows that the lens is confined in its proper position behind the pupil.

Notwithstanding the soft consistence of the exterior portion of

* Fig. 83 shows the difference of convexity in the lens at different periods of life, as represented by Sömmering. To the left is the lens of a fœtus. The middle one is that of a child six years of age; the right is that of an adult. The lens varies in consistence as well as colour, as life advances. In infancy it is soft and pulpy, in youth firmer, so as readily to be crushed between the thumb and finger—and in old age it becomes tough and firm. Hence the operation of cutting up the lens for the cure of cataract, is more appropriate in children than old persons, in whom, from its toughness, it is apt to roll under the needle and inflict injury on the iris.—P.

the lens, there is reason to believe that it has a peculiar organisation; for if it be immersed some time in a diluted solution of the nitrate or muriate of alumine, or in several other fluids, and then dried, it will be found to be composed of concentric lamellæ, which resemble those of the bulbous roots; and these lamellæ will appear to consist of fibres.

It has been supposed that muscular fibres entered into the composition of the crystalline lens, but this opinion has never been generally adopted.*

Between the lens and its capsule a small quantity of a transparent fluid is sometimes found, which escapes whenever the capsule is punctured. This fluid is supposed to be most abundant on the anterior surface, and is called liquor Morgagni.

—The lens, according to Berzelius, consists of a peculiar coagulable albuminous matter, 35.9—alcoholic extract with salts, 2.4—watery extract with traces of salts, 1.3—membrane forming the cells, 2.4—water, 58.0. The liquid contained in its cells is more concentrated than any other in the body. The albuminous matter is peculiar, inasmuch as the concentrated solution instead of becoming a coherent mass on the application of heat, becomes granulated, exactly as the colouring matter of the blood when coagulated, from which it only varies in the absence of colour, and differs from fibrine in not coagulating spontaneously. —The lens, which at first sight appears to be a simple homogeneous body, more consolidated, so as to form a sort of nucleus, at the centre, is in fact as elaborately organised as any part of the body. The concentric lamellæ of which it is composed are resolvable into fibres. The arrangement of these fibres differs in the different classes of animals; according to Sir D. Brewster, in birds and some fishes, as the cod and haddock, the fibres converge in straight lines, from the two opposite poles of the spheroidal lens, like the meridians of a globe. In some other fishes, in reptiles, and a few of the mammalia, the fibres do not start from a single point, but from two septæ at each pole. The third or more complex structure exist in the mammalia in general, in

* See Dr. Young's Memoir in the Philosophical Transactions for 1793.

which *three septæ*, as in Fig. 84, diverge from each pole of the lens, at angles of 120 degrees; the septa of the anterior surface bisecting those of the posterior. The mode in which these fibres are laterally united, is very intimate—by a sort of reciprocal indentation or rack-work. The lens in its embryotic developement, is formed in three separate parts, which are subsequently united at the poles. If the lens is macerated for a short time in water, or water acidulated with mineral acid, it separates readily from the centre to the circumference in layers which may readily be reduced to fibres, as seen in the human lens and in the lens of a fish, (*Lophius piscatorius*,) Fig. 85, taken from Professor Jacob.

Fig. 84.

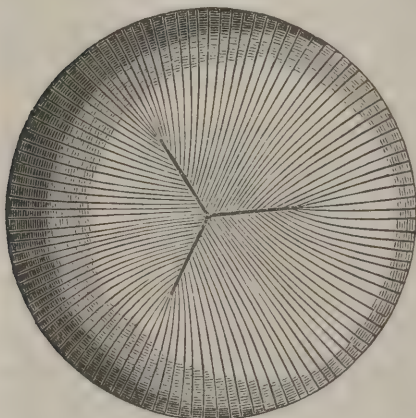
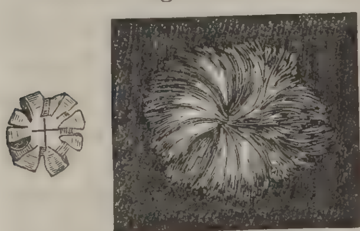


Fig. 85.*



—The opaque structure of the lens opens in this way in many cases of cataract and presents the stellated appearance seen through the transparent capsule.—The fluid called liquor Morgagni, said to exist between the capsulė and lens, Professor Jacob considers a post mortem result, like that of the pericardium; the fluid escaping from the cells of the lens. In the eyes of domestic animals examined

* The small figure to the left in this cut, represents the human lens, macerated in water containing a few drops of acid for several days, when it is found split open by fissures extending from its centre to its circumference. The large figure to the right, is the lens of a fish prepared in the same way by Mr. Jacob; its fibres unfolded with a delicate needle, and presenting a tufted appearance.—P.

shortly after death no fluid is met with, but if many hours are allowed to elapse, a small quantity is found in the capsule. My own observations made both with the naked eye, and with the use of a strong lens, are in confirmation of his views.

—This distinguished anatomist considers the semicartilaginous transparent capsule to be applied, immediately on the surface of the lens, and to preserve its pulpy exterior in the proper curvature.

—Between the lens and capsule there is evident connexion at the back part, where Albinus has injected a vessel passing from the capsule to the lens. When the anterior part of the capsule is opened, Mr. J. believes it is the contraction or shrinking of the capsule which breaks the connexion, and forces the lens from its bed; an occurrence which we find does not always take place in operations upon the eye, without artificial aid.—

No blood-vessels are to be seen in any of the humours of the eye, or their capsules, excepting those of the fœtus. In the fœtus a branch can be traced from the central artery of the retina, through the vitreous humour, to the posterior surface of the crystalline capsule, on which it ramifies. In similar subjects vessels have been seen passing from the ciliary processes to the anterior surface of the capsule; and it is also asserted by very respectable anatomists that they have seen vessels passing from the capsule into the substance of the lens.

The *use of the crystalline lens* is to concentrate the rays of light, so as to form a distinct image at the bottom of the eye.

The Aqueous Humour

Occupies the space which is between the crystalline lens and central extremities of the ciliary processes and the cornea. This space is divided by the iris into two chambers, very dissimilar in figure, which communicate with each other by means of the pupil. The posterior chamber is much smaller than the anterior, and its existence has been doubted; but it is easily proved by freezing the eye, when it is found filled with a part of the aqueous humour in a state of congelation.

The *aqueous humour*, in a natural state, is perfectly transparent; but in the fœtus, and for a short time after birth, it is red-

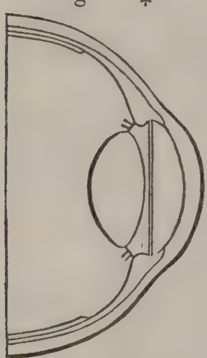
dish and turbid. It consists of water impregnated with albumen, gelatine, and muriate of soda; and of course resembles the fluid of the vitreous humour.

It is probable that this fluid has also a capsule appropriated to it; for, after boiling an eye, a delicate membrane can be found lining the internal surface of the cornea, and extending from it over the anterior surface of the iris. It has not yet been traced as far as the pupil, but it is probable that it extends through the pupil, and lines the posterior chamber also.*

The aqueous humour is quickly renewed after it has escaped in consequence of wounds or operations, and blood, accidentally effused into its cavity, is often absorbed.†

This fluid preserves the convexity of the cornea, and admits the free motions of the iris; allowing, at the same time, a ready passage to the rays of light.

Fig. 86.‡



—The annexed enlarged cut from Sömmering, shows accurately the comparative size of the two chambers of the aqueous humour, and how the posterior is formed by the iris in front, the capsule of the lens behind, and the ciliary processes, and a small portion of the hyaloid tunic between these processes and the margin of the capsule, upon the side.

—Petit has calculated, that the whole amount of the aqueous humour, does not weigh more than four or five grains, and that the space between the iris and the capsule of the lens is less than a

* This capsule was discovered by Messrs. Demours and Descomet, who disputed each other's claim in 1767. It is thought to be useful in preventing the cornea from being penetrated by the aqueous humours, and the pigmentum nigrum from being washed off the iris, and making this humour turbid. M. J. Cloquet says, that he has traced it in the posterior chamber of the eye. From this account it appears that there is one capsule, in early fœtal life, for the anterior chamber, and another for the posterior chamber, and that the Membrana Pupillaris is formed by these capsules being stretched across the pupil, back to back.—H.

† The aqueous humour, according to Mr. Hunter, can be coagulated with Goulard's Extract.—H.

‡ Memoirs of French Academy for 1721.

quarter or half a line; while Winslow insisted, that the iris and capsule were in contact in youth and middle life, when the pupil was contracted.

—Certain it is that adhesion takes place readily between them, and that the posterior chamber is so narrow, that no surgeon can with any certainty introduce an instrument into it, without the risk of wounding the vascular ciliary processes, or the iris.

—The following are the dimensions and admeasurements made by Petit and Young, of the different parts of the globe of the eye.

	Inches.
Length of the optical axis, . . .	0.91
Vertical cord of the cornea, . . .	0.45
Versed sine of the cornea, . . .	0.11
Horizontal cord of the cornea, . . .	0.47
Diameter of pupil as seen through ditto,	0.27 to 0.13
Distance of iris from cornea, . . .	0.11
Distance of iris from anterior surface of lens .	0.02
Radius of anterior surface of lens, . .	0.30
Radius of posterior surface of lens, . .	0.22
Principal focal distance of lens, . .	1.73
Distance of the centre of the optic nerve from the central fold, (*yellow spot, limbum luteum,*) in the axis of vision, ...	0.11
Range of eye, or diameter of the field of vision,	1.100

It will be very beneficial to every student of anatomy to dissect this delicate organ himself, as he will thereby acquire more accurate and precise ideas of its structure than he can possibly obtain from the ordinary demonstrations.

The eyes of sheep and oxen will serve very well for beginners, as many of them will be required, and they can be easily obtained. They resemble the human eye in many respects; and the circumstances in which they differ may be readily ascertained by the diligent student; especially if he dissects the human eye afterwards.

For this purpose, it will be requisite to have forceps, finely pointed; with knives and scissors that are equally delicate in structure; and also a pair of strong scissors, bent like those in the cases of pocket instruments.

When removing the exterior parts, it will be useful to preserve a portion of the optic nerve, to take hold of.

The dissection of the coats of the eye can be best performed when the eye is placed in a vessel of water; which should be shallow or deep, according to the different stages of dissection.

In some dissections it will be serviceable to form a bed of jelly, to support the eye, as proposed by Mr. C. Bell.

As the first process in this operation, the sclerotic coat can be readily separated from the choroides, and the cornea with it.

After examining the external surface of the choroides, the ciliary ligament, and the iris, the iris may be peeled off from the choroides.

The choroides, by a careful process, may then be separated from the retina, which it leaves surrounding the vitreous humour. The ciliary processes, being a part of the choroides, come away with it.

The preparation being in water may now be suspended by the optic nerve. It consists of the vitreous and crystalline humours and the retina. The retina, originating from the optic nerve, adheres anteriorly, also, with so much firmness, that it will support the part enclosed.

The retina may be removed without lacerating the tunics of either of the humours; and the pigmentum nigrum, which often adheres to that part of the vitreous humour which was connected with the ciliary processes, may be washed away with a piece of soft sponge. By this washing, the radiated grooves in the vitreous humour, which were connected with the ciliary processes, will be very apparent.

To examine the iris in its natural situation, an aperture may be made in the cornea of a fresh eye near its circumference, and the cornea cut out with the strong scissors. This exposes the anterior surface of the iris.

The iris may then be easily removed, and the crystalline lens, with the central extremities of the ciliary processes surrounding it, will be exposed to view.

To examine the ciliary processes on the other side, a lancet may be plunged into another eye, somewhat anterior to the middle, and the eye divided by means of the strong scissors. The anterior section should then be laid on the cornea, and the ciliary process will appear very distinctly, seen through a portion of the vitreous humour. The retina may also be seen at the same time, and a judgment may be formed of its extent. The view will be more distinct, if part of the vitreous humour should be cut away with the scissors and forceps, so as to lessen the quantity without deranging the parts under it.

Several methods have been proposed for rendering the structure of the vitreous humour, and the processes of the tunica hyaloidea, more distinct. None of them have been very successful: but, if the vitreous humour be suspended in water by means of a thread passed through that part which surrounds the crystalline lens, and some large incisions be made into the most depending part of it, after some days of suspension its bulk will be

diminished, by the discharge of the fluid. If, in this situation, it be immersed in a solution of nitrate of silver, the tunica hyaloidea will become very apparent; and, by various degrees of exposure to light, may have its colour varied from a whitish opacity to a dark brown.

The appearance of the retina is also much changed by immersion in the solution of nitrate of silver. This effect of the solution, at first sight, appeared calculated to decide the question respecting the extent of the retina; but, after several applications, it could only be said, that the pulpy substance of the retina appeared to terminate at the commencement of the ciliary processes, while a membrane of a different texture seemed continued from it to the crystalline lens.

CHAPTER XV.

OF THE EAR.

The organ of hearing is composed of three distinct parts, viz. 1. The exterior portion, which, although merely auxiliary, is denominated the *External Ear*. 2. A chamber, situated in the petrous portion of the temporal bone, which is called the *Cavity of the Tympanum*. 3. A deeper seated cavity in the same bone, which, from its complicated form, is denominated the *Labyrinth*.

Of the External Ear.

The *External Ear* consists of the expanded portion, exterior to the head, commonly called the *Ear*, and a wide tube passing from it to the cavity of the tympanum, called *Meatus Auditorius Externus*.

The form of the *Ear* is so familiar to every one, that it is not necessary to describe it. The uppermost and longest portion is denominated *Pinna*. The small pendulous part below is called *Lobus*.

The form as well as the firmness of the *pinna*, depends entirely upon a cartilage: the *lobus* consists of skin and cellular membrane.

The skin which covers the pinna is particularly delicate; and, when the cuticle is separated from it by maceration, it appears to be perforated with an unusual number of foramina, which are the orifices of the sebaceous glands. It is connected to the subjacent cartilage by a dense cellular membrane, which, in most places, is free from adeps.

The cellular membrane of the lobus contains adeps very delicately arranged.

The circumference of the ear is formed by a fold of the margin of the cartilage: and this folded edge is denominated *Helix*,

from its winding direction. It commences in the cavity called *Concha*, to be presently described; and, after proceeding forwards and upwards, it turns round backwards and downwards.

Within this prominent margin is a second prominence, called the *Antihelix*, which appears to be formed by a convexity of the surface of the cartilage, but is found in every ear. It is nearly semicircular, with its concavity towards the meatus; and it forms the margin of the cavity called *Concha*, above mentioned. The upper portion of the antihelix consists of two superficial ridges, which unite after forming between them a shallow depression, the *Fossa Navicularis*, or *Scapha*.

The helix and antihelix form, therefore, three cavities or depressions, viz. 1. A sulcus, occasioned by the fold of the helix, which is sometimes called *Fossa innominata*. 2. The *Fossa Navicularis;* and 3. The *Concha*, which may be considered as the proper orifice of the ear.

Besides these prominences and fossæ there are two other eminences, called *Tragus* and *Antitragus*, formed, also, by this cartilage. The *Tragus* is anterior to the meatus auditorius, and covered by a continuation of the skin of the face. It projects backwards, so as partly to cover the meatus. On the inside of it there is commonly a tuft of hair, from which its name is derived.

The *Antitragus* is opposite to the tragus, on the posterior margin of the concha.

On the posterior surface of the ear the convexity of the concha is very conspicuous.

When the skin and cellular membrane is carefully removed, and the cartilaginous skeleton of this structure is examined, its form will not appear so regular as that of the undissected ear; for there are several deficiencies or vacuities in it; the most remarkable of which is between the tragus and the helix.

The cartilage thus formed is attached to the bones of the face and cranium, by three ligamentous membranes, which connect it to the zygomatic and the mastoid processes of the temporal bone, and to the aponeurosis on the squamous portion of the same bone.

In addition to the common muscles of the ear, described at p. 274, vol. i. there are a few muscular fibres, which, *in some subjects*, may be discerned on particular parts of the cartilage, and therefore are considered as muscles proper to these portions of the ear.

There are five of these portions of fibres; two on the helix, one on the tragus, one near the antitragus, and the fifth on the other side of the ear.

The *Major Helicis* is on the anterior and most prominent part of the helix above the tragus. The *Minor Helicis* is lower down on the helix in the concha.

The *Tragicus* lies on the tragus, and the *Antitragicus* behind the antitragus, while the *Transversus Auris* is on the other side of the ear, on the prominence formed by the concha near its circumference.

It may be observed respecting the muscles of the ear, that even the common muscles, which are by far the largest, are unable, in many persons, to move that organ; and the proper muscles, in a large majority of mankind, cannot be perceived to produce any effect at all.

There are difficulties in explaining the form of the cartilage; for, notwithstanding the well known opinion of the geometrician said to have been employed by Boerhaave, that the line of reverberation is directed to the meatus auditorius externus from every part of the ear, in many persons the cartilage is so situated that the concha appears to be the principal, if not the only part, from which sound can be reverberated into the meatus.

It may be questioned whether the backward position of the ear, which is commonly observed at the present day, is altogether natural; as a more prominent position seems much better calculated for the reverberation of sound; but this position of the cartilage is observable in many infants at birth.

It is asserted by some comparative anatomists, that the cartilage is stronger and more elastic in proportion to its size, in man, than in any other animal; and that the lobus is peculiar to the human ear.

The *Meatus Auditorius Externus* is a tube, extending from the

concha to the membrana tympani, the external extremity of which is principally composed of cartilage, and the internal of bone. The cartilage in the external portion of the tube is a continuation of the substance of the concha. It does not solely form a complete tube, for, when the meatus is opened longitudinally and spread out, this cartilage appears triangular in shape; a fibrous membrane being joined to it to complete the tube.

In addition to the deficiency thus arising, there are two others, one of which, that has a transverse position, is of considerable size. These deficiencies are called *Incisuræ;* and the fibrous structure which closes that which is transverse, has been called by Santorini, who described it, *Musculus Incisuræ Majoris.*

The cartilage is attached to the bony portion of the meatus at the lower part of its margin, and forms about one half of the length of the meatus.

The skin covering the external ear is continued into the meatus, and lines it throughout; extending over the incisuræ, and also over the membrana tympani. It adheres more firmly to the periosteum of the bony part of the meatus than to any other portion of the canal. Some fine hair is often observable growing out of it at the external extremity. As the skin advances deeper in the meatus it becomes more and more delicate and sensible. The extreme pain excited by the penetration of an insect, or the introduction of an instrument, into the ear, evinces the great degree of sensibility with which it is induced.

Exterior to the skin, in the cellular membrane which surrounds it, are many small glands* of a yellowish colour, whose ducts open upon the surface of the meatus, and pour upon it the substance called *cerumen* or ear-wax. These glands are most numerous about the middle of the meatus and at those places in which the cartilage is deficient. The cerumen is fluid at first, and gradually thickens. In some diseases of the meatus it has the appearance of pus. The use of this secretion is probably to exclude insects, for which it is well calculated by its tenacity

* Discovered by Stenon, in 1662.—H.

and bitterness; and also to defend the delicate surface upon which it is spread.

The direction of the meatus is inwards and forwards: it is also curved, with the convexity upwards; but it is very easy, by management of the external ear, to admit the rays of the sun to the bottom of the meatus, and bring the membrana tympani into view.

—Its length, in the adult, is about ten or twelve lines. It is a little greater along the inferior part of the meatus, in consequence of the oblique manner in which it is closed at its internal extremity, by the membrana tympani. See Plate xiii.

—The cerumen is composed, according to Vauquelin, of a fatty oil, of a peculiar albuminous substance, and yellow colouring matter. According to Rudolphi and Fourcroy, the bitter principle of the cerumen is the same as that of the bile.

—The external ear is a simple acoustic instrument, a sort of trumpet, for the purpose of catching the sonorous vibrations, and transmitting them to the membrane of the tympanum, to which it is connected by the meatus auditorius externus. Its removal, however, does not appear to impede, very seriously, the function of hearing, as the rays still find their way down the meatus. It is not found in purely aquatic animals, but in those only which hear through the medium of the air. In some birds, and some reptiles, there are, in front of the tympanum, two sorts of lips, susceptible of opening and shutting, like the eyelids.—

A vertical section of the meatus is of the oval figure. In the fœtus the bony part of this duct is not formed, and the meatus consists entirely of cartilage.

Of the Cavity of the Tympanum.

The meatus auditorius externus is terminated abruptly by the membrana tympani, which forms a septum that closes it completely.

On the inner side of this septum is the *Cavity of the Tympanum*, which may be regarded as the continuation of the *bony meatus.*

It differs, however, from the form of this canal; for its diameter is greater, and it is not so regularly cylindrical.

It is not deep; as the distance from the membrana tympani, which constitutes the external side, to the opposite internal side, is seldom more than three or four lines.

—Its antero-posterior diameter is about six lines, and its vertical diameter rather more: though from the inequality of its surface, and its connexion with the mastoid cells and Eustachian tube, it is difficult to assign its exact dimensions.—

The breadth of the cavity of the tympanum is, therefore, greater than its depth.

It is situated immediately between the membrana tympani, and the labyrinth which is on the inside of it.

In its natural state this cavity has two apertures; one which communicates with the fauces, by means of the *Eustachian Tube;* and another which leads into the cellular structure of the mastoid process.

There are also two deficiencies in the bony plate, which separates it from the labyrinth, called the *Foramen Ovale*, and *Foramen Rotundum;* but in the natural state of the parts these deficiencies are closed, and there is no direct communication of the tympanum either with the labyrinth or the meatus auditorius externus: the only direct communications being those above mentioned, with the fauces and the mastoid cells.

That deficiency in the bone between the tympanum, and the labyrinth, which is called *Foramen Ovale*, is closed by one of the small bones of the ear, called the *Stapes*. The other deficiency, called *Foramen Rotundum*, is covered by the membrane which lines the tympanum.

In the cavity of the tympanum are four of the smallest bones of the body, which are articulated with each other so as to form one flexible piece. This piece is attached by one end to the *membrana tympani*, and the other to the *Foramen Ovale;* and it is moved by small muscles connected with it.

The cavity of the tympanum is lined by a membrane which has been considered as similar to the periosteum: but it is as-

serted by Bichat that this membrane, when inflamed, resembles the mucous membranes; and that in its natural state it secretes a mucus which passes into the fauces by the Eustachian tube.

This lining membrane is continued over the internal surface of the membrana tympani, and was supposed by the aforesaid author to be reflected so as to cover the small bones of the ear.

The opinion of Bichat, respecting the nature of the membrane, is rendered probably by analogical reasoning, viz. The internal surface of the cavity must be in want of mucus or cuticle, as it is in contact with the air. The membrane is very sensible in a sound state, and therefore is very different from periosteum, which it was supposed to resemble.

—The tympanum or middle ear, is but an accessory part of the organ of hearing, the use of which is to augment and transmit sound received through the medium of the air. It is found only in mammalia, birds, and reptiles. The whole organ of hearing in fishes, consists merely in a membranous bulb, placed at the exterior, and upon which is ramified the auditory nerve. —The most simple idea that can be formed of the tympanum, (as seen in its developement in the human fœtus and in inferior animals,) is, that of a cylindrical prolongation of the mucous membrane of the pharynx, to the front part of the labyrinth. There it is dilated to form the cavity of the drum, and contracted on the side of the pharynx to form the Eustachian tube. A bony shell is subsequently formed around the drum, and the tympanic half of the Eustachian tube. The closure of the tympanum by bone, is not complete. The membrana tympani forms part of the wall on the side of the meatus. The internal wall of the cavity of the tympanum, is formed by the bony labyrinth. The mucous membrane reflected from the pharynx into the cavity of the tympanum, is extremely thin and delicate, is very vascular and receives many filaments of nerves. It lines the whole circumference of the cavity, as well as the mastoid cells communicating with it, and is reflected over the chain of bones, and subserves the part of capsular ligament in holding them together at their articulation.—

The Membrana Tympani,

Appears to be fixed, in a bony ring in the meatus auditorius, and is nearly circular in form. It is not perpendicular to the meatus, but has an oblique position in it; the inferior margin projecting farther inwards than the superior.

The external surface forms a conical concavity, being apparently drawn in by the malleus, one of the small bones of the ear, to which it is attached.*

It is asserted by several anatomists, that this membrane may be separated into four lamina. viz. 1. The *Cuticle;* and, 2. The *Cutis;* which are continued from the skin of the meatus externus. 3. The proper *Membrana Tympani;* and 4. The *Lining Membrane of the Tympanum;* which is extended over the internal surface of the membrana tympani. Notwithstanding these laminæ, it is almost transparent in the *living subject*, when in a healthy state, and appears highly polished on its external surface, when light is thrown upon it. It has been injected so as to appear vascular in every part; and one or two vessels are sometimes seen even in common injected preparations. In some cases of inflammation it has been uniformly red.

It was formerly asserted by Rivinus, a professor at Leipsic, that there was a natural aperture in this membrane; but although this opinion has had several votaries, it is certainly erroneous. At the same time it is to be observed, that an aperture, occasioned by accident or disease, is sometimes perceived in persons who enjoy the faculty of hearing to a considerable degree. Some persons, thus circumstanced, are accustomed to force tobacco smoke from the mouth through the ears.

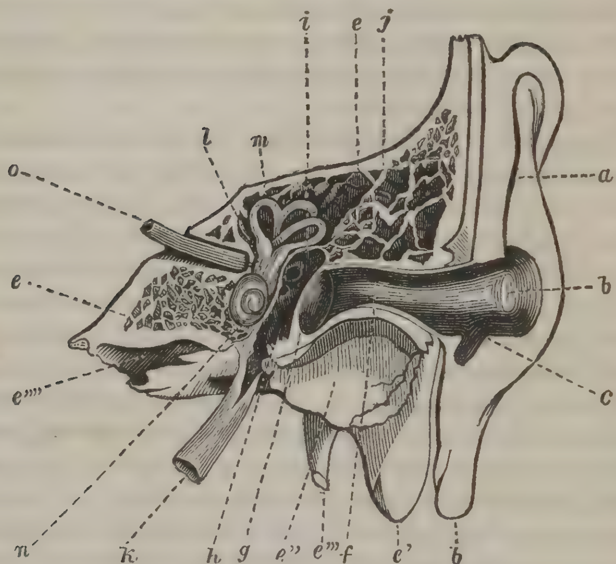
It is asserted by a respectable anatomist† that the membrana tympani, when viewed in a microscope, which will magnify twenty-three times, appears to be supplied with muscular fibres

* In birds, it is always found *convex* outwards. This is a universal mark of distinction in the membrana tympani of birds and mammalia, the two classes of animals only, in which it exists as a thin vibrating membrane.—P.

† See Mr. Home's Memoir on the structure and uses of the membrana tympani, in the Philosophical Transactions for 1800.

arranged in a radiated manner. These fibres are on the internal side of the membrane. He thinks that, under favourable circumstances, they can be seen with the naked eye.

Fig. 87.*



The Eustachian Tube.

The communication between the cavity of the tympanum and the fauces is formed by the *Eustachian Tube*, a canal which con-

* Fig. 87 represents a vertical section of the auditory apparatus of the left side; the labyrinth being a little enlarged, in order to render its description more intelligible to the student. *a*, External ear. *b*, Lobus of the ear. *c*, Antitragus. *d*, Concha, the bottom of which is continuous with the meatus auditorius externus. *e*, *e*, Petrous portion of the temporal bone, in which the auditory apparatus is lodged. *e'*, Mastoid process of the temporal bone. *e''*, Portion of the glenoid cavity of the temporal bone, in which is articulated the condyle of the lower maxillary bone. *e'''*, Styloid process of the same bone. *e''''*, Extremity of the carotid canal, traversed by the internal carotid artery, before it penetrates into the cavity of the cranium. *f*, Meatus auditorius externus. *g*, Membrana tympani. *h*, Cavity of the tympanum, from which the chain of bones have been removed. *i*, Two openings leading into the cells of the petrous portion of the temporal bone. On the

sists of bone at one extremity, and of cartilage at the other. It commences in the upper and anterior part of the cavity of the tympanum, and continues forwards and inwards through a part of the petrous portion of the temporal bone, above the fissure in the cavity for receiving the condyle of the lower jaw. The bony canal terminates in a very rough and irregular orifice, which is united to a tube composed of cartilage and of membrane, that terminates by a large orifice behind the inferior turbinated bone of the nose, and on a line with it.

—The whole length of the Eustachian Tube is nearly two inches. The bony portion is about eight lines long; the cartilaginous from an inch to an inch and a quarter. The latter rests against the side of the internal pterygoid process of the sphenoid bone, to the periosteum of which it is attached; and on its under surface gives attachment to some of the muscles of the palate. The course of the tube is nearly horizontal, as it runs outwards, backwards, and slightly upwards. The opening of the tube into the fauces is funnel-shaped and large enough to receive the end of the little finger. It contracts suddenly, at the place of union of the cartilaginous and bony portion, and it is there barely large enough to admit a good sized bristle. From this point the calibre of the tube again increases somewhat in size, in its course to the cavity of the tympanum.—

This tube is lined by a continuation of the membrane of the posterior nares, which becomes more thin as it proceeds towards the cavity of the tympanum.

Above the Eustachian Tube, and separated from it by a thin plate of bone, is a small canal which is nearly parallel to it, and continues so to the end of the petrous bone; this contains the internal muscle of the malleus.

internal wall of the cavity of the tympanum, are seen two openings, the *fenestra ovalis*, leading to the *Vestibule*, *l*; and the *fenestra rotunda*, leading to the *cochlea*, *n*. *m*, Semicircular canals. *k*, Eustachian tube leading from the pharynx to the cavity of the tympanum. *o*, Auditory nerve. The protuberance made on the internal wall of the cavity of the tympanum, is called the *promontory*. The opening called *apertura chordæ*, and the pyramid, are on the posterior wall of the tympanic cavity, and cannot be well seen in this figure.

The Mastoid Cells.

In the upper and back part of the cavity of the tympanum, nearly opposite to the orifice of the Eustachian Tube, is an opening which communicates with the cells of the mastoid process. These cells do not appear different from those in other bones, and are lined with a membrane apparently similar. Their size is proportioned to that of the mastoid process, and consequently they do not exist in the fœtus.

—The mastoid cells or sinuses, communicate freely with one another, and with the cavity of the tympanum, at the posterior superior part of the latter. The opening into the cavity of the tympanum is irregular and lodges the short leg of the incus. The mastoid cells, are analogous in structure to the frontal and sphenoidal sinuses; they differ entirely from the common cellular tissue or diploic structure of bones. The latter is placed between the two tables of the bones, whilst the sinuses have both tables on their exterior, forming their varieties with the usual diploic structure between them.—

Foramina and Protuberances of the Tympanum.

That part of the surface of the cavity of the tympanum which is opposite to the membrana tympani, is very irregular, but it contributes to the formation of several parts which are very important in the structure of the ear.

When the lining membrane is removed, the aperture called *Foramen Ovale* (*fenestra ovalis*), appears in a conspicuous situation, rather above the middle of this surface. It would open directly into the *Vestibule*, or middle chamber of the *Labyrinth;* but it is closed by the base of the stapes.

Above the foramen ovale is a prominence of the surface, in which passes the canal for the *Portio Dura* of the seventh pair of nerves.

Under the above mentioned foramen is a more striking protuberance called the *Promontory*, within which is a part of the *Cochlea*, the anterior division of the *Labyrinth.*

At the under and posterior part of the promontory is the *Fo-*

ramen Rotundum (*fenestra rotunda*), which opens into the *Cochlea.* This foramen is smaller than the foramen ovale; and in its recent state is covered by the membrane which lines the tympanum.

—According to M. Ribes,* the membrane closing the fenestra rotunda, is a *secondary membrane of the tympanum,* formed of three layers; viz. the lining membrane of the tympanum, the lining membrane of the cochlea, and between them a peculiar middle membrane like that which closes the bottom of the meatus auditorius externus.

—It is probable that a similar arrangement, exist at the fenestra ovalis, and upon which the stapes rests, though it has not been satisfactorily demonstrated.

—The size of both these fenestræ, is greatly inferior to that of the membrana tympani.—

Behind the foramen ovale is a protuberance with a perforation in it. This is called the *Pyramid.* It is excavated, and contains the muscle of the stapes, which passes out through the perforation.

The Bones of the Ear.

The four small bones in the cavity of the tympanum are denominated *Malleus, Incus, Orbiculare,* and *Stapes.* (See Fig. 88, p. 426.)

The *Malleus* resembles a crooked club more than any of the hammers now in use. It consists of an irregular roundish head, a neck, and a long tapering body, called the *Manubrium,* or *handle.* It has also two processes; one arising from the neck, which is long and slender, like a bony fibre, and, therefore, called *Gracilis.* The other, called *Brevis,* arises from the upper end of the handle. The handle of the Malleus forms an angle with its body, the salient side of the angle presenting outwards: the space from this angle to the termination of the manubrium, or in other words the whole manubrium is connected with the membrana tympani.

The *Incus* resembles a *molar tooth,* with two roots, widely separated from each other. On the body is a depression which is connected with the head of the malleus. One of the roots or crura is much longer than the other.

* Memoire sur Quelques Parties de l'Oreille Interne.

The *Os Orbiculare* is equal in size to a small grain of sand. It is connected to the extremity of the long crus of the incus, and to the upper part of the stapes.

The *Stapes* has a strong resemblance to the common stirrup. The upper part is called its *head*, the lower part its *base*, and the two lateral portions its *crura*. One of the crura is longer than the other. A groove is also observed on the inner side of its crura, when they are examined with a microscope. The base is applied to the *Foramen Ovale.*

The situation of these bones is such that the head of the malleus and the body of the incus are in the upper and anterior part of the cavity of the tympanum, which extends above the membrana tympani. The malleus is the most anterior of the two bones: its manubrium projects downwards, and is included between the internal lamen of the membrana tympani and the membrane itself. Its long process extends horizontally, inwards and forwards, into the fissure of the glenoid cavity.

The incus is so placed that the depression on its body receives the head of the malleus. The shortest leg projects backwards horizontally, and is attached by a ligament to a point in the opening into the mastoid cells. While the long leg projects downwards like the handle of the malleus, but behind it, and at a small distance inwards from the membrana tympani.

The situation of the stapes is almost at right angles with the long leg of the incus, projecting inwards. Between the head of the stapes and the long leg of the incus, the os orbiculare intervenes.

When these bones are viewed in their natural position, the short leg of the incus projects horizontally backwards, the long process of the malleus horizontally forwards; the handle of the malleus, and the long leg of the incus, directly downwards, one connected with the membrana tympani, and the other with the foramen ovale, by the intervention of the orbiculare and stapes.*

* Lassus, in his excellent discourse on Anatomy, informs us that Fallopius and Eustachius described nearly the whole interior of the ear. The most ancient authors had remarked the thin and transparent membrane which closes the extremity of the meatus externus. Fallopius described particularly the tympanum; of the

The Muscles of the Bones of the Ear.

The aforesaid bones appear to be regularly articulated for motion with each other, and they are furnished with several muscles.

One of these muscles runs in the bony canal above the Eustachian tube, and is inserted into the posterior side of the handle of the malleus, below the root of the long process. Its effect is to draw in the malleus and membrana tympani. It is therefore called *Tensor Tympani*, or *Internus Auris*.

Another muscle, as it is supposed to be, runs in the fissure on the outside of the Eustachian tube, and is inserted into the long process of the malleus.

This is supposed to draw the malleus obliquely forward, and of course to relax the tympanum. It is therefore called *Laxator Tympani*, or *Externus Mallei;* but there are the strongest doubts respecting the muscularity of this organ.

Morgagni, Haller, Lieutaud, and Meckel, could not satisfy themselves that it was muscular; and Sabatier also doubts it; while Bell, Fyfe, Hume, Bichat and Gavard, appear to adopt the opinion of its muscularity.

Some anatomists describe a third muscle of the malleus as arising from the superior posterior margin of the meatus auditorius, where the membrana tympani adheres to it, and uniting to the neck of the malleus. It is supposed to draw the malleus and membrana tympani upwards and forwards. This, however, is noticed by few authors. (It is called the *Laxator Tympani minor.*)

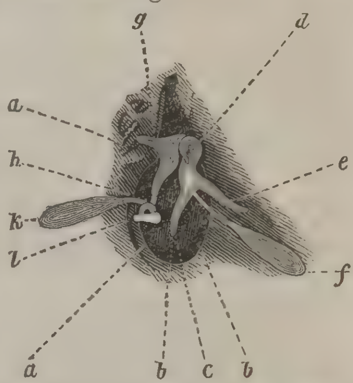
The stapes is also supplied with one muscle called the *Stapedius*, which lies in the cavity of the pyramid. Its tendon passes through the foramen in that protuberance, and is inserted into

four bones within it, the malleus, incus, os orbiculare, and stapes; Berenger de Carpi described the two first; Ingrasias, Eustachius, Columbus, and Louis Collada, a Spanish physician, disputed the discovery of the fourth with each other; and Vesling assures us that Francis de la Boe, a Dutch physician, discovered the third, which is the smallest.—H.

the posterior part of the head of the stapes. It pulls the head of the stapes upwards and backwards.

—Breschet, in a recent admirable paper on the organ of hearing, after very careful researches on the subject, admits but two muscles to the chain of bones, the tensor tympani or internus auris, and the stapedius, which he calls laxator tympani. In birds, there is but one muscle attached to the chain of bones, and that is a tensor of the tympanum. In reptiles, when the chain of bones was met with, Breschet was unable to discover any muscle.—

Fig. 88.*



The Chorda Tympani.

In the upper and posterior part of the cavity of the tympanum is a small nervous chord which enters by a foramen near the basis of the pyramid, and passing downwards and forwards, goes out at an aperture in the fissure of the cavity for the head of the lower jaw. In this course it crosses the long leg of the incus, and the manubrium of the malleus, and passes between them, being in contact with the manubrium.

This nerve comes off from the portio dura immediately be-

Fig. 88, is a magnified representation of the cavity of the tympanum, and its chain of bones. *a*, *a*, Cavity of the tympanum. *b*, Membrani tympani. *c*, Manubrium of the malleus, the end of which is attached to the middle of the membrani tympani. *d*, *Head* of the malleus articulated with the incus. *e*, *Processus gracilis*, arising below the neck of the malleus, and extended into the glenoidal fissure of the temporal bone; upon its extremity is inserted the laxator tympani muscle of the malleus, if it really exist. *f*, Tensor tympani muscle. *g*, Incus, the horizontal short leg of which is placed in the cavity leading to the mastoid cells, the long vertical leg of which is articulated with the os orbiculare, *h*. *i*, Stapes, the top of which is articulated with the os orbiculare, and the base rests upon the membrane, closing the fenestra ovalis. *k*, Stapedius muscle.—P.

fore it emerges from the foramen stylo-mastoideum, and after passing a short distance through a small canal, enters the cavity of the tympanum as above described. After passing out of the cavity of the tympanum, it joins the lingual branch of the fifth pair of nerves.

It was believed by the late Mr. John Hunter, that the chorda tympani is not simply a branch of the portio dura, but that it is the twig of the reflected branch of the spheno-palatine nerve, which, entering the os petrosum by the *Vidian Foramen*, joins the portio dura; and after passing with it a considerable distance, leaves it at the place above described.*

There is the greatest reason to believe that the principal object of the structure above described, is to transmit to the labyrinth those impulses of the air which occasion sound. The membrana tympani, with the small bones and their muscular appendages, seem to be the agents for this purpose. The Eustachian tube and the mastoid cells are subservient parts. The effect of the chorda tympani in the cavity has not been ascertained.

With this view of the subject, it is surprising that persons, in whom the membrana tympani has been destroyed, should enjoy the sense of hearing in a very considerable degree of perfection. Such, however, is the fact.

It is necessary that there should be a communication between the cavity of the tympanum and the external air, in order that the function may be duly performed.

This is evinced by the deafness which results from the obstruction of the Eustachian tube, and the cure of this deafness by relieving that obstruction; as well as by the salutary effects of opening the membrana tympani;† and even of instituting a communication through the mastoid cells, in cases where the obstruction of the Eustachian could not be removed.

It has been supposed that the Eustachian tube has the effect of transmitting sound to the ear, and particularly the voice of the individual of whose structure it is a part; and it is certain that we hear our voices very distinctly, (although peculiarly modified,) when the external orifice of the ears are closed: but the well-known fact, that a small watch, when placed in the mouth, and not in contact with any part of it, is scarcely heard, if

* I have followed Mr. H. in this dissection, and have no doubt of his opinion being correct.—H.

† See Dr. Sim's paper on this subject, in the first volume of Memoirs of the Medical Society of London; and Astley Cooper's, in the London Philosophical Transactions.

heard at all, renders this opinion very doubtful. It ought, however, to be remembered, during the investigation of this subject, that persons who hear with difficulty are almost invariably in the habit of opening their mouths when they listen.

Of the Labyrinth.

Those parts of the organ of hearing which have been already described, seem calculated for concentrating the vibrations of air; and for communicating, with some modification, the motion they occasion, to the *Labyrinth.*

This important portion of the ear consists of *three very dissimilar parts,* which communicate with each other, and form one *general* cavity.

The central part of the cavity is a chamber, of a form which approaches to the oval, and has been compared to that of a grain of barley. It is called the *Vestibule.*

At one extremity of this chamber (the posterior) are three tubes, each of which is curved so as to form a large portion of a circle. These tubes communicate with the vestibule, by each extremity; but they form only five orifices, because two of their extremities are united before they open into the vestibule. These tubes are denominated the *Semicircular Canals.*

At the other extremity of the vestibule is a conical tube convoluted like the shell of a snail. This is called the *Cochlea.* It also communicates with the vestibule.

The *Labyrinth,* thus complicated in its form, is situated on the inner side of the cavity of the tympanum. Its position in such, that the *Vestibule,* and the *Cochlea* are opposite to the *Membrana Tympani,* and the *Semicircular Canals* are posterior to it. The apex of the cochlea is on the side of the labyrinth which is next to the tympanum, the basis of the cochlea is next to the brain.

The texture of the bone which immediately surrounds these cavities is much harder than that of the other parts of the os petrosum; and if the bone of a fœtus be used, these softer parts may be cut away so as to leave behind the bony substance which surrounds these cavities, corresponding exactly to their form.

The *Labyrinth*, when thus prepared, may be considered as a solid body which has been enveloped in a softer substance, and is brought into view by detaching the soft substance, which surrounded it.

In the fœtus it is nearly as large as in the adult, so that the structure of the ear can be investigated with great advantage in such subjects.

The Vestibule

Is situated within the *Foramen Ovale.* There are two remarkable depressions of its internal surface; one, which is in the superior part, is called *Semi-elliptical;* the other, which is below, has the name of *Hemispherical.*

When the dried preparation is examined, there are several foramina in this cavity, viz. the *Foramen Ovale,* already mentioned. A *round aperture,* by which it communicates with one of the cavities of the cochlea, and the five openings of the semicircular canals. Besides these, there are several small perforations from the *Meatus Auditorius Internus* for the transmission of nerves.

The Cochlea

Commences at the anterior part of the vestibule. It is a conical tube, so convoluted that it has the form of the shell of a snail making two circuits and a half round a centre.

It may be considered as wound in a spiral direction round a pillar of bone. To this central pillar the name of *Modiolus* is applied. It commences at the cavity called *Meatus Auditorius Internus;* and its base is somewhat excavated. It gradually diminishes in diameter as it proceeds towards the apex of the cochlea, and is, therefore, conical in form; but it does not preserve this form to its termination, for near the apex it gradually becomes broader, and thus forms a second cone inverted. This last portion of the central pillar is called the *Infundibulum.* It is hollow; and the portion of bone which covers its cavity, constitutes the basis of the inverted cone and the apex of the cochlea. It is called the *Cupola.*

The tube thus wound round the modiolus, or the cochlea, is divided from the beginning to the end by a partition.

The cavities are called *Scalæ*, and the partition *Lamina Spiralis.*

The *Lamina Spiralis* is made up of four parallel strips, which compose its breadth.

1st. A plate of bone.

2d. Outside of this, a softer plate, which appears cartilaginous.

3d. A cellular portion, which appears to contain a pellucid fluid.

4th. A thin membranous strip, which completes the septum or partition.

These parts may be distinguished from each other, when magnifying glasses of sufficient power are used.

The bony plate is composed of two lamina with small cancelli between them, in which are canals for the transmission of the fibres of nerves. These canals are extended into the cartilaginous part.

The membranous part which completes the septum is continued into the lining membrane on the surface of the cochlea.

The bony portion of the scala does not extend towards the apex of the cochlea so far as the cartilaginous and membranous portions; and none of them continue to the apex, for the lamina spiralis terminates in the infundibulum before it had arrived at the apex. Its extremity has the form of a hook, and is, therefore, termed *Hamulus.*

As this septum does not extend to the apex of the cochlea, the two scalæ necessarily communicate with each other at the apex.

These different bands or strips which compose the lamina spiralis, are called its *Zones*, and are termed *Zona Ossea*, *Zona Coriacea*, *Zona Vesicularis*, and *Zona Membranacea.*

From what has been stated it follows that there are two cavities in the cochlea, each of which continues throughout its whole extent. One begins at the vestibule; the other at the tympanum. But a membrane extended over the foramen rotundum separates this last from the tympanum. They communicate with each

other at their terminations. From their origins they are denominated *Scala Vestibuli* and *Scala Tympani.*

As both the cochlea and the vestibule are filled with a fluid, it is evident that a vibration produced on the membrane of the foramen rotundum may be communicated through the two scalæ to the vestibule.

The three Semicircular Canals

Are placed obliquely behind the vestibule. Their position is such that one is *Superior*, another *Posterior*, and the third *Exterior.* The superior and posterior are so placed that one extremity of each may be considered as internal and the other external. They unite at their internal extremities, which therefore form but one orifice in the vestibule. Their other extremities, being separated to a considerable distance, form each one orifice; while the external canal, which is smaller than the others, opens by two orifices.

Each of these canals is nearly of the same diameter, viz. rather more than two lines.

At one of their extremities, each one of them has an enlargement, which is called *Ampulla;* and there is no other variation of their diameters.

The cavity of the labyrinth, thus complicated, is perforated by many small foramina, through which various nerves are transmitted.

These foramina communicate with the large canal on the posterior side of the petrous bone, called *Meatus Auditorius Internus;* which continues very near to the basis of the cochlea, and transmits the seventh pair of nerves.

The bottom of this cavity is divided by a ridge into two unequal fossæ; the uppermost of which is the least.

In the *Upper Fossa* are two foramina; the anterior, which is the largest, serves to transmit the *Portio dura*, a part of the seventh pair, to be hereafter described, which passes through the petrous bone to the face. The posterior foramen forms a pit with a cribriform bottom, which admits nervous fibrillæ to the vestibule.

The anterior part of the *Inferior Fossa* is also cribriform; its perforations lead to the cochlea; one of them, which passes through the modiolus to the infundibulum, is larger than the rest. The posterior part of this fossa is occupied by foramina, which pass to the vestibule and semicircular canals; but they are not so numerous as those which lead to the cochlea.

Contents of the Labyrinth.

This interesting cavity is lined throughout by a delicate membrane. It contains sacs and tubes, and a plexus of delicate nerves, which constitute a soft labyrinth within that which is composed of bone.

In the cavity of the *Vestibule* are two sacs distinct from each other, and also from the lining membrane.

One of these denominated *Sacculus Sphericus*, or *Sacculus Vestibuli*, is situated partly in the *Hemispherical Cavity* of the vestibule, and has no direct communication with any other part.

It contains a limpid fluid, and is said to have so much firmness, that when opened with the point of a lancet, it will retain its form.

The other sac is situated partly in the depression called *Semi-elliptical*, nearly opposite to the foramen ovale: it is so transparent that it is sometimes seen with difficulty, and appears like a bubble of air in a fluid. All the membranous semicircular canals, which are soon to be described, communicate with it by each of their extremities: it has been called *Alveus Communis* by Scarpa, and *Utriculus* by Sömmering.

In the bony canals already described, are *three Membranous Semicircular Canals*, which resemble them in form. They have an ampulla at one extremity, as they arise from the sac above mentioned, and are cylindrical during the remainder of their course; they are transparent, and have smaller diameters than the bony canals, although they are rather longer.

The Auditory Nerve.

Upon this structure, viz. *the Sacs in the Vestibule, the Membranous tubes in the Semicircular Canals*, and *the Lamina*

Spiralis of the Cochlea, are expanded the fibres of the *Auditory Nerve.*

This nerve, with the *Portio Dura*, and its appendage, the *Portio Media*, composes the seventh pair of nerves of the brain.

It is called *Portio Mollis*, and is very distinct from the *Portio Dura*, although they pass together along the *Meatus Auditorius Internus.*

Corresponding to the foramina and the cribriform structure of the bottom of the meatus auditorius internus, the *Auditory Nerve* passes into the labyrinth in branches, or fibrillæ, of various sizes. One portion of them enters the vestibule, and has been traced upon the alveus or utriculus, and its internal surface; and also upon the semicircular membranous tubes. Another portion seems exclusively appropriated to a part of these tubes. And a third is spent upon the sacculus sphericus.

These nervous fibres seem to terminate in a pulpy expansion on the internal surface of the aforesaid sacs and canals, in a way which has some analogy with the termination of the optic nerve.

A large bundle of these fibrillæ enters the cochlea at its base; and the largest of them passes through a foramen, mentioned before, along the centre of the modiolus to the infundibulum.

These fibrillæ divide most minutely, and passing between the plates of the *Lamina Spiralis*, as well as the other parts of the bony structure of the cochlea, at length form a plexus, which has the appearance of a pulpy membrane, that is extended over the whole of the lamina spiralis. Thus is the auditory nerve distributed.

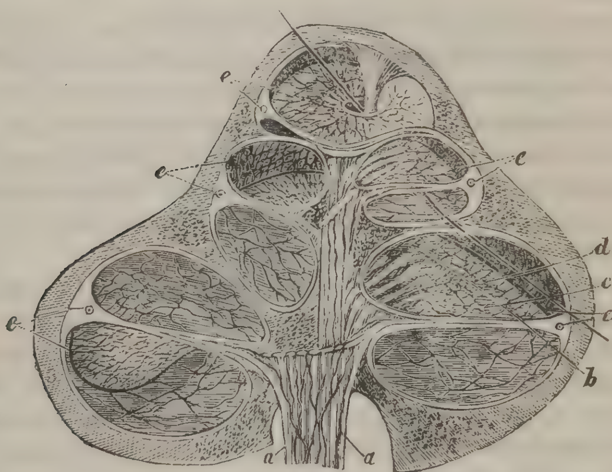
—The central portion of the modiolus, contains a great number of minute canals, and which is in consequence called by Scarpa the *tractus spiralis foraminulosus*. Into these the nerves of the cochlea enter, and pass out successively at right angles, between the two bony plates forming the *zona ossea* of the lamina spiralis, to be expanded on the membranous portion of the lamina. The nervous pulp is expanded in a naked state, and the neurilema which it throws off, forms, according to Breschet, the basis of the membranous structure of the lamina spiralis.—

To complete the account of the labyrinth, it is to be observed

that a pellucid fluid certainly exists in it, exterior to the sacs in the vestibule, and to the membranous semicircular canals; so that the membranous labyrinth may be said to be immersed in a fluid.

This fluid fills, also, the cochlea.

Fig. 89.*



—A useful distinction has been made by many anatomists of the parts of the labyrinth or internal car, into a *bony labyrinth*

* Fig. 89, is a vertical section of the cochlea through its axis, in order to exhibit its internal structure, much magnified. *a a a*, Branch of the auditory nerve to the cochlea (*nervus cochlearis*), over which the veins are seen running and penetrating in small branches through the lamina spiralis. The arteries are not shown here, but they have the same course as the veins. *b*, Filaments of the nerve, lodged in the zona ossea of the cochlea. *c c*, Anastomoses of the filaments of the nerve with one another in the form of loops, in the zona media. *d*, The neurilema abandoning the nervous loops, in order to form, according to Breschet, the zona membranosa. The blood-vessels are seen accompanying all these branches. *e*, A venous sinus, excavated in the bone, at the outer margin of the *zona membranosa*. The venous sinus *e*, opens at the margin of the lamina spiralis, which divides the scala tympani below from the scala vestibuli above. Between the windings of the double tube, which resemble the turns of a circular pair of stairs, is seen a process of bony matter passing in to the modiolus. The bristle is passed in at the infundibulum, through the scala tympani, and brought out through the scala vestibuli, showing the communication of these cavities.—P.

and a *membranous labyrinth.* The bony labyrinth, consisting of the bony vestibule, cochlea, and semicircular canals, forms only the frame-work or walls to more important parts. The sacs of the vestibule, the membranous lining of the cochlea, and the membranous semicircular tubes, are parts upon which the auditory nerves and vessels are distributed, and are the parts immediately concerned in the production of hearing. The membranous cochlea, so far at least as has yet been observed, lines the internal face of the scala of the bony cochlea, and appears to serve as its periosteum as well as a field for the expansion of the cochleary division of the auditory nerve. The vestibule and the semicircular canals have a periosteal lining membrane distinct from their membranous structure and from which the limpid fluid of the labyrinth is secreted. The membranous sac of the vestibule, and the membranous canals, occupy but a small part of their respective bony cavities, with the walls of which, according to the recent researches of Breschet, they are only indirectly connected by the nerves and blood-vessels which enter their structure through foramina in the bony labyrinth. The limpid fluid alluded to, (p. 375,) called the lymph of Cotunnius, from the anatomist who first described it, is found not only filling the cavities of the membranous labyrinth, but likewise fills up completely the space between the membranous and bony vestibule, and the membranous and bony canals. It is asserted by Brugnone and Ribes, that the lymph but partly fills the cavity in its natural condition; but Breschet,* from elaborate researches in man and a variety of vertebrated animals, asserts this to be an error.† The membranous structure is afloat as it were in this fluid, and is affected by the slightest impulse communicated to the fluid, through the membrane closing the foramen rotundum and foramen ovale, with which the fluid is in contact. The endolymph is denser in fish than in land animals. M. E. Barruel has examined it che-

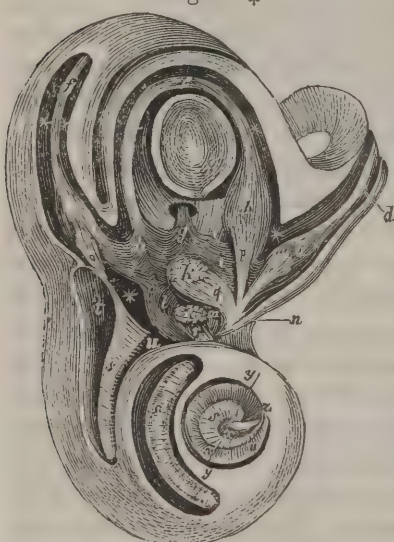
* Recherches Anatomiques et Pathologiques sur l'Organs de l'Ouie, et sur l'Audition, dans l'Homme et les Animaux Vertébres; par G. Breschet. Memoires de l'Academie Royale de Medecine; tom. v.

† Cotugno and P. F. Meckel held the same opinions as Breschet.

mically in the great seal, (Squalus Cat. L.) He found it viscous and transparent, containing a matter floating in it, which when dried formed a calcareous powder.

—For the sake of clearness of description, Breschet proposes to call the fluid within the membranous labyrinth the *endolymph;* that between it and the bony labyrinth the *perilymph.* The auditory nerves terminate in delicate villi, which project in the cavities filled by the endolymph, and in order to give the sonorous impulse transmitted from without more effect upon the nerves, there is placed in the cavity of the labyrinth from one to three calcareous substances which are thrown into agitation by the impulse. These have been long known to exist in the ears of osseous fishes, as small concretions of carbonate of lime, see Fig. 90, called *otoliths ;** and Breschet has found them invariably to exist, in the state of granular powder which he calls *otoconie,*† in man, the three upper classes of vertebrated animals, and in cartilaginous fishes. The cavity in which the perilymph is contained in the cochlea, vestibule and semicircular canals, is continuous, so that an impulse transmitted through the membrane of the foramen rotundum, would pass along the scala tympani across the infundibulum, down the scala vestibuli, and be felt both in the vestibulum and semicircular canals. In the same

Fig. 90.‡



* Οὖς, ωτος, ear ; λιθος, stone. † Οτος, κονις, εως, powder, dust, etc.

‡ Fig. 90, Represents a magnified view of the bony labyrinth of the right side of the body, with the membranous labyrinth (consisting of semicircular tubes, median or utricular sinus sometimes called *sacculus ellipticus* and *sacculus sphericus*), pulverulent concretions, and the termination of the nerves. The two scala of the

manner the action of the chain of bones upon the foramen ovale, would be felt through the entire labyrinth.

—It has been suggested that the two foramina, ovale and rotundum, are provided for the purpose of rendering more complete the transmission of the vibration of the membrana tympani; one acted on by the chain of bones, the other by the air of the tympanic cavity; both at the same time causing movements in the *lymph*, at opposite points in the labyrinth, which should pass once through different portions of the labyrinth, agitate all the parts on which the nerves are spread, and finally neutralise each other, in the semicircular canals and in the scala of the cochlea, so as to prevent the repetition and reverberation of single sounds.

—The calcareous concretions above alluded to, are found, in the mammiferæ, only in the alveus communis and sacculus ellipticus of Scarpa, in which the semicircular tubes open, and which Breschet calls the middle sinus. They form a small single granular mass. Opposite these concretions the auditory nervous filaments termi-

cochlea are also seen, and their openings into the vestibule and into the cavity of the tympanum. The bony labyrinth is represented as cut open, showing the membranous labyrinth. All the parts marked with the asterisks (**) are filled with the lymph of Cotunnius. *a*, Ampulla of the anterior or semicircular canal. *b*, Ampulla of the internal semicircular canal. *c*, Ampulla of the posterior semicircular canal. *d*, Anterior membranous semicircular canal. *e*, External membranous semicircular canal. *f*, Posterior membranous semicircular canal. *g*, Common membranous canal resulting from the junction of the anterior and posterior canals, *d* and *f*. *h*, Place where the semicircular canal opens into the utricular or median sinus. *i*, *i*, Utricular or median sinus, filling a great part of the vestibule, and exhibiting through its walls a mass of calcareous powder at *h*, (*otoconie utriculaire.*) *l*, *l*, Sac containing also a mass of calcareous powder at *m*, (*otoconie sacculaire.*) *n*, Nervous fasciculus, forming an expansion, *o*, on the ampulla of the anterior canal; another, *p*, on that of the external; and a third, *q*, on the *sinus utriculosus*. *r*, Nervous fasciculus distributed on the sac. *v*, Nervous fasciculus distributed on the posterior ampulla. *s*, *s*, Lamina spiralis. *s*, End of the lamina, forming its hamulus or hook. *t*, Commencement of the scala tympani near the fenestra rotunda, which is not shown here. *u*, Commencement of the scala vestibuli. *x*, Modiolus or column, round which is wound the lamina spiralis. *y*, *y*, Bristle engaged in the infundibulum (*Helicotrome*), by which the two scala communicate together at the top of the modiolus. *z*, Place where the modiolus is continuous at its summit, with the walls of the osseous labyrinth. *w*, *w*, *w*, Membranous portion of the lamina spiralis.—P.

nate in great number, and the prominent villi which they form seem even to reach the concretions.

—Gregoire St. Hilaire and Breschet, have instituted comparisons between the parts of the labyrinth which form the organ of hearing proper, and the parts contained in the globe of the eye. The endolymph they call the *vitrine auditive*, and compare it to the vitreous humour, in allowing the sonorous rays or impulses to pass through it, and in keeping distended the membranous labyrinth upon which the nerves terminate, and which they consider analogous to the retina. The light calcareous concretions are, as they think, for the purpose of increasing the effect of the impulses, as the crystalline humour increases the effect of the luminous rays by concentrating them into a focus. Arnold and Tiedemann consider the membrana tympani as analogous in its office to the iris, regulating, by its state of tension or relaxation, the degree of impression made upon the nerves of hearing. The comparison is rendered more complete, by the recent discovery by Arnold, of an auricular ganglion, which is considered as an appendage of the sympathetic nervous system, and which, according to them, is the central regulator of the sympathetic, or instinctive movements of the membrana tympani, as the ophthalmic ganglion is of that of the iris.

Of Jacobson's Anastomosis, or the Nervous Plexus of the Tympanum and the Auricular Ganglion of Arnold.*

—The cavity of the tympanum receives nerves from various sources, which communicate together upon the walls of that cavity so as to form a plexus, and which are chiefly spent upon the parts situated in the tympanic cavity.

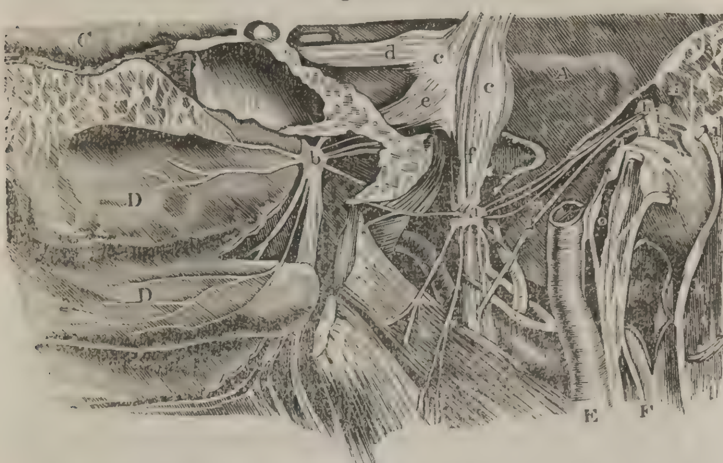
—This plexus is formed by branches from the great sympathetic,

* The existence of this plexus was first made known by M. Jacobson, of Copenhagen, who first traced an anastomosing loop from the glosso-pharyngeal nerve through the cavity of the tympanum, which there left branches, and thence was reflected downwards to join the third branch of the fifth pair. Since then, the nerve has been shown to terminate, or arise in a ganglion, discovered by Arnold, of Zurich, on the lower surface of the third branch of the fifth pair of nerves, called *auricular ganglion, ganglion oticum, ganglion maxillo-tympanique.*—P.

the glosso-pharyngeal, the trigeminal or fifth pair, the facial, the auricular ganglion, and the pneumogastric.

—This plexus, see Fig. 91, is found on the outside of the walls of the cranium, and on the outer face of the inner wall of the cavity of the tympanum. It is found in all animals endowed with a tympanum: and in fishes that possess only an auditory bulb, formed by the labyrinth, it is found spread in a few filaments on the outer face of the bulb, the usual situation of the tympanum in other animals.

Fig. 91.*



—Shortly after the glosso-pharyngeal nerve emerges from the jugular fossa, it forms a gangliform enlargement, called the

* Fig. 91 exhibits a view of the *auricular ganglion* of Arnold, and its connexions with surrounding parts . *A*, Right side of the cranium. *B*, petrous portion. *C*, Cribriform plate of the ethmoid bone. *D*, Turbinated bone. *E*, Carotid artery. *F*, Internal jugular vein. *a*, otic ganglion, sending off its branches to the tympanum, to the soft palate, and its descending twigs of communication. *b*, Ganglion of Meckel, or spheno-palatine ganglion. *c*, Ganglion of Gasser, or semilunar ganglion of the fifth pair of nerves. *d*, Ophthalmic nerve. *e*, Superior maxillary nerve. *f*, Inferior maxillary nerve. *g*, Chorda tympani. *h*, Malleus. *i*, Incus. *k*, Glosso-pharyngeal nerve. *l*, Ganglion formed on this nerve, called *ganglion of Andersch* or *ganglion petrosum*. *m*, *m*, Branches from it through the tympanum to the auricular ganglion called Jacobson's Anastomosis. *n*, Branches of communication between this nerve, and the carotid plexus and ganglion, *o*.—P.

ganglion of Andersch, from the anatomist who first described it, or *ganglion petrosum*, from its proximity to the petrous bone. From this ganglion passes, upwards and forwards, the nerve of Jacobson, and enters a small canal, the orifice of which opens in the excavated border, which separates the carotid canal from the jugular sinus. The nerve emerges from the canal near the anterior border of the fenestra rotunda, traverses the promontory, comes in front of the foramen ovale, passes below the anterior part of the tensor tympani muscle, and curves forward between this muscle and the Vidian nerve, to terminate in the auricular ganglion of Arnold.

—In the latter part of its course it is parallel with the proper nerve of the tensor tympani muscle, which comes off from the ganglion of Arnold.

—This is the usual method of describing the course of this nerve, but we might, according to Breschet, with equal propriety adopt the views of Arnold, and consider it as arising from the ganglion, which is evidently the fact in regard to many of the inferior animals, as the nerve is larger near the ganglion, than in the tympanic cavity. As it enters the tympanum, it gives off one filament to the fenestra rotunda and the mucous membrane surrounding it, and another to the membrane surrounding the margin of the foramen ovale. Whilst in the bony structure of the promontory it gives off several filaments through canals in the bone; viz. several filaments of communication pass through the osseous wall of the carotid canal to unite with the carotid plexus of the sympathetic; others form a junction with the vidian or chorda tympani nerve. A filament from the pneumogastric (the tympanic) anastomoses with it, either before or after its entry into the cavity of the tympanum; a filament is sent off in the direction of the Eustachian tube, and another branch is occasionally met with, between this nerve and the portia dura, which Breschet is disposed to think is continuous with the pars media of the seventh pair of nerves. Many minute blood-vessels accompany these branches. See Fig. 91.

—The auricular ganglion of Arnold, is small, though more than double the size of the ophthalmic, and is ash-coloured and pulpy like those of the sympathetic nerve. It is situated in ad-

vance of the ganglion of Gasser, on the lower surface of the inferior maxillary nerve at the inner margin of the foramen ovale of the sphenoid bone. The existence of this ganglion may readily be detected by any one skilled in minute dissection.

—It is united by short nervous roots, and cellular tissue to the third branch of the fifth pair of nerves. Besides the branches mentioned as coming from the auricular ganglion, Arnold, Breschet, and others, describe branches of communication which pass from it; one to the superior cervical ganglion of the sympathetic, along the tract of the arteria meningea magna, one which passes into the internal auditory meatus to anastomose with the auditory nerve, as well as other branches which unite with filaments of the fifth and facial nerves. I have not as yet been able to trace these filaments with satisfaction, and those who have attempted to follow minute nervous fibrils through bony parts can well appreciate the difficulties of the undertaking. The German anatomists in general, consider this ganglion, as well as the ophthalmic, spheno-palatine, etc., as so many appendages or cranial terminations of the sympathetic nerve.—

The Aqueducts.

It is, probably, on account of this fluid, that two small canals exist; which are called, after the anatomist who first suggested their use, the *Aqueducts of Cotunnius.**

One of these commences in the scala tympani of the cochlea, near the foramen ovale; and terminates in the jugular fossa, by a small orifice, situated before the spine that separates the eighth pair of nerves from the internal jugular vein. It is called the *Aqueduct of the Cochlea.*

The other originates in the vestibule, under the common orifice of the two canals, and terminates on the posterior surface of the petrous bone, by a small orifice, which is situated at some distance behind the meatus auditorius internus. It is called the *Aqueduct of the Vestibule.*

—The aqueducts of the cochlea and vestibule are large in the fœtus and during the growing period of the bone; and as Itard has first observed, become in old age extremely minute and often

* See Sandiford's Thesaurus Dissertationum, &c. vol. i.

entirely obliterated. The external orifice of the aqueduct of the vestibule corresponds to a venous sinus (*sinus petrosum*), and that of the cochlea to the internal jugular veins. The researches of Brugnone and Ribes have shown conclusively that the aqueducts are simple foramina for the introduction of veins.—

To this account of the ear it ought to be added, that the *Portio Dura*, after entering into the petrous bone by the foramen in the upper fossa of the meatus auditorius internus, proceeds in a canal which is called the *Aqueduct of Fallopius*, through the bone, to the foramen stylo-mastoideum, on its inferior surface, where it emerges, and is distributed to the face. It is therefore called the *Facial Nerve* by some anatomists.

In the course of this nerve from the meatus through the solid bone, it forms a remarkable angle, and then passes between the cochlea and the semicircular canals, to the foramen stylo-mastoideum.

In this course it soon receives the Vidian nerve already mentioned; and it sends off the chorda tympani, immediately before it passes out at the foramen stylo-mastoideum. It also sends off small fibrils to the muscles of the bones of the ear.

It has not been ascertained whether the portio dura, the Vidian nerve, and the chorda tympani, have any effect upon the function of hearing.

The situation of those branches of the auditory nerve which are expanded in the vestibule and the semicircular canals, is somewhat different from the situation of those which are in the cochlea; but it has not yet been ascertained how far their functions are different.

The information on this subject derived from comparative anatomy, is very interesting; but, for want of more acquaintance with the state of this function, in the different animals, no very decisive inferences have been drawn from it.

The vestibule and semicircular canals occur much more frequently than the cochlea, which is to be found in few animals, if any, besides those of the classes of mammalia and of birds. It is therefore supposed necessary to that perfect state of hearing which the animals of these classes enjoy. But there remains a considerable difficulty on this subject; the cochlea is not, by any means, so perfect in birds as in quadrupeds; yet many birds appear to have clear perceptions of musical sounds, and some birds imitate articulate sounds with considerable accuracy.

That the impression which produces hearing is made on the nervous expansions in the Labyrinth, does not appear to be doubted by any one. The structure of the whole organ, and the analogy between it and the eye induce a strong belief that this is the case.

This belief is confirmed by a dissection recorded by Mr. Haighton,* in which *Original Deafness* was found to depend upon a quantity of cheese-like matter, which filled the whole labyrinth, and was attended with a considerable diminution of the size of the auditory nerve, while all the other parts of the organ were in a perfectly natural state.

* See Memoirs of the Medical Society of London, vol. 3.

EXPLANATION OF PLATE XIII.

Fig. 1. Shows the Lachrymal Canals, after the Common Teguments and Bones have been cut away.

a, The lachrymal gland. b, The two puncta lachrymalia, from which the two lachrymal canals proceed to c, The lachrymal sac. d, The lachrymal duct. e, Its opening into the nose. f, The caruncula lachrymalis. g, The eyeball.

Fig. 2. An Interior View of the Coats and Humours of the Eye.

a a a a, The tunica sclerotica cut in four angles, and turned back. b b b b, The tunica choroides adhering to the inside of the sclerotica and the ciliary vessels are seen passing over—c c, The retina which covers the vitreous humour. d d, The ciliary processes which were continued from the choroid coat. e e, The iris. f, The pupil.

Fig. 3. Shows the Optic Nerves, and Muscles of the Eye.

a a, The two optic nerves before they meet. b, The two optic nerves conjoined. c, The right optic nerve. d, Musculus attollens palpebræ superioris. e, Attollens oculi. f, Abductor. g g, Obliquus superior, or trochlearis. h, Abductor. i, The eyeball.

Fig. 4. Shows the Eyeball with its Muscles.

a, The optic nerve. b, Musculus trochlearis. c. Part of the os frontis, to which the trochlea or pulley is fixed through which,—d, The tendons of the trochlearis pass. e, Attollens oculi. f, Adductor oculi. g, Abductor oculi. h, Obliquus inferior. i, Part of the superior maxillary bone to which it is fixed. k, The eyeball.

Fig. 5. Represents the Nerves and Muscles of the Right Eye, after part of the Bones of the orbit have been cut away.

A, The eyeball. B, The lachrymal gland. C, Musculus abductor oculi. D, Attollens. E, Levator palpebræ superioris. F, Depressor oculi. G, Abductor. H, Obliquus superior, with its pulley. I, Its insertion into the sclerotic coat. K, Part of the obliquus inferior. L, The anterior part of the os frontis, cut. M, The crista galli of the ethmoid bone. N, The posterior part of the sphenoid bone. O, The transverse spinous process of the sphenoid bone. P, The carotid artery, denuded where it passes through the bones. Q, The carotid artery within the cranium. R, The ocular artery.

Nerves.—a a, The optic nerve,—b, The third pair. c, Its joining with a branch of the first branch of the fifth pair, to form l,—The lenticular ganglion, which sends off the ciliary nerves, d. e e, The fourth pair. f, The trunk of the fifth pair. g, The first branch of the fifth pair, named ophthalmic. h, The frontal branch of it. i, Its ciliary branches, along with which

ANATOMY

Plate XIII.

the nasal twig is sent to the nose. k, Its branch to the lachrymal gland. l, The lenticular ganglion. m, The second branch of the fifth pair, named superior maxillary. n, The third branch of the fifth pair, named inferior maxillary. o, The sixth pair of nerves—which sends off p, The beginning of the great sympathetic. q, The remainder of the sixth pair, spent on c, The abductor oculi.

Fig. 6. Represents the head of a youth, where the upper part of the cranium is sawed off,—to show the upper part of the brain, covered by the pia mater, the vessels of which are minutely filled with wax.

A A, The cut edges of the upper part of the cranium. B, The two tables and intermediate diploe. B B, The two hemispheres of the cerebrum. C C, The incisure made by the falx. D, Part of the tentorium cerebelli superexpansum. E, Part of the falx, which is fixed to the crista galli.

Fig. 7. Represents the parts of the External Ear, with the Parotid Gland and its Duct.

a a, The helix. b, The antihelix. c, The antitragus. d, The tragus. e, The lobe of the ear. f, The cavitas innominata. g, The scapha. h, The concha. i i, The parotid gland. k, A lymphatic gland, which is often found before the tragus. l, The duct of the parotid gland. m, Its opening into the mouth.

Fig. 8. A view of the posterior part of the external Ear, meatus auditorius, the tympanum with its small bones, and Eustachian tube, of the right side.

a, The back part of the meatus, with the small ceruminous glands. b, The incus. c, Malleus. d, The chorda tympani. e, Membrana tympani. f, The Eustachian tube. g, Its mouth from the fauces.

Fig. 9. Represents the anterior part of the right external Ear, the cavity of the tympanum—its small bones, cochlea, and semicircular canals.

a, The malleus. b, Incus, with its long leg resting upon the stapes. c, Membrana tympani. d, e, The Eustachian tube covered by part of—f f, The musculus circumflexus palati. 1, 2, 3, The semicircular canals. 4, The vestibule. 5, The cochlea. 6, The portio mollis of the seventh pair of nerves.

Fig. 10. Shows the Muscles which compose the fleshy substance of the Tongue.

a a. The tip of the tongue, with some of the papillæ minimæ. b, The root of the tongue. c, Part of the membrane of the tongue, which covered the epiglottis. d d, Part of the musculus hyo-glossus. e, The lingualis. f, Genio-glossus. g g, Part of the stylo-glossus.

PART XI.

OF THE NERVES.

The nerves are those whitish cords which pass from the brain and spinal marrow to the various parts of the body.

A general account of their origin is contained in the description of the basis of the brain and of the spinal marrow,* which may be considered as introductory to the present subject.

The nerves, in general, appear to be bundles or fasciculi of small cords, each of which is composed of a series of fibres that are still smaller. These fibres consist of medullary matter, which is derived from the brain and spinal marrow, and is enclosed in a membranous sheath that appears to arise from the pia mater. The smaller the fibre, the more delicate is the membrane which invests it.

As the nerves proceed from the brain and spinal marrow, through the foramina of the cranium and the spine, they are enclosed in a sheath formed by the dura mater; but when they arrive at the exterior extremities of the foramina in those bones, this coat, derived from the dura mater, appears to separate into two lamina. The exterior lamen combines with the periosteum, and the interior continues to invest the nerve, but seems to change immediately into cellular substance; so that the exterior coat of the nerves may be regarded as composed of cellular membrane, which is continued from the sheath derived from the dura mater.

It has been supposed that the membrane which forms the sheaths for the medullary fibrils of which the nerves are com-

* See volume ii. page 354.

posed, is of a peculiar nature; but it appears to be derived from the pia mater, investing the brain and the spinal marrow. It is very vascular.*

The ramification of a nerve is simply the separation of some fibres from the general fasciculus. The branch commonly forms an acute angle with the main trunk.

The course of these branches from their origin to their termination is generally as straight as possible.

When the nervous cords are examined in an animal recently dead, there is an appearance of white lines arranged in a transverse or spiral direction. The cause of this appearance is not well understood.

In various parts of the body networks are formed by the combination of different nerves or the branches of nerves. In those instances the branches of one nerve unite with those of another, and form new branches. These new branches again divide, and their ramifications unite with other new ramifications to form other new trunks. These new trunks divide again, and form new combinations in the same way.

The trunks last formed proceed to the different parts of the body, as other nerves do which arise immediately from the brain.

These combinations are denominated *Plexuses.* There are several of them in the cavities of the abdomen and thorax, formed by the ramifications of the par vagum and the sympathetic nerves. The four lower cervical, and the first dorsal nerve, form a very remarkable plexus of this kind, which extends from the side of the neck to the axilla, and forms the nerves of the arm. The lumbar nerves form a similar plexus, although not so complex, from which the crural nerve arises. The anterior nerves of the sacrum also unite for the formation of the great sciatic nerve.

* Several authors have written professedly on the structure of the nerves, viz. Monro, in his "Observations on the Structure and Functions of the Nervous System."—Bichat, "Anatomie Generale."—Fontana, "Treatise on the Poison of the Viper."—Reil, "Exercitationes Anatomicæ."—Scarpa, "Annotationes Academicæ."—Prochaska, "De Structura Nervorum."

I regret that it has not been in my power to procure Reil, Prochaska, or Scarpa.

It appears to be clearly ascertained, that the great object of this peculiar arrangement is the combination of nervous fibres from many different sources, in each of the nerves, which are distributed to any organ. Thus, the smaller nerves of the arm, that are distributed to the different parts, are not to be regarded simply as branches of any one of the five nerves which are appropriated to the upper extremity, but as composed of fibres which are derived from each of them.

Many of the nerves are enlarged in particular places, so as to form small circumscribed tumours, which are denominated *Ganglions.*

These *Ganglions* are generally of a reddish colour. By very dexterous management, they can be shown to consist of a texture of fibres. The larger cords which compose the nerve, seem suddenly to be resolved into the small fibres, of which they consist. These small fibres, after proceeding separately a greater or lesser distance, according to the size of the ganglion, and changing their relative situation, are again combined in cords, which recompose the nerve.

These fibres appear to be surrounded by a fine cellular substance, which is vascular, moist, and soft. It is asserted that, in fat subjects, an oily substance, resembling fat; and in hydropic subjects, a serous fluid has been found in this texture.

Ganglions are often connected with but one nerve, which seems to enter at one extremity and go out at the other. But they frequently receive additional branches from other nerves, and send off additional branches to parts different from those to which their principal nerves are directed. When connected with but one nerve, they have been called *simple ganglions:* when they receive and give off additional branches, they are denominated *compound ganglions.* It does not appear that there is any important difference in their structure, in these cases.

The simple ganglions occur in the nerves of the spinal marrow—the posterior fasciculus of the nerves having always formed a ganglion before it is joined to the anterior fasciculus. The sympathetic nerve, throughout its whole extent, forms compound ganglions.

The use of this particular structure does not appear to be perfectly known. It seems, however, certain, that the different fibres—(of which the nerves forming ganglions are composed)—are blended together and arranged in a manner different from that in which they were arranged before the nerve entered the ganglion.

It ought to be observed, that the combination of nervous fibrillæ, so as to bring together those fibrils which originally belonged to different cords, seems to have been kept in view throughout the whole arrangement of the nervous system. It is not only in the plexus and the ganglion that this appears, but, also, in some of the larger nerves; for in them the fibres which form the cords that compose the nerve, instead of running parallel to each other, along the whole extent of the nerve, form a species of plexus in their course, separating from the fibres with which they were originally combined, and uniting with the fibres of other cords; as in other cases of plexus.*

There have been doubts respecting the possibility of a reproduction of the substance of the nerves when it has been destroyed; but it appears to have been clearly proved by the experiments of Mr. Haighton, that a reproduction does really take place.†

Nine pair of nerves proceed from the brain through the foramina of the cranium. They are called *Nerves of the Brain*, or *Cerebral Nerves.* One pair passes off between the cranium and the spine, which is called *Sub-Occipital.* Twenty-nine or thirty pair pass through the foramina of the spine: they are denominated *Cervical*, *Dorsal*, *Lumbar*, and *Sacral*, from the bones with which they are respectively connected. There are seven pair of cervical nerves, twelve dorsal, five lumbar, and five or six sacral—amounting, with the nerves of the brain, to thirty-nine or forty pair.

Nerves of the Brain.

The nerves which go off from the brain and medulla oblon-

* See Monro's Observations on the Structure and Functions of the Nervous System. Plate xviii.

† See London Philosophical Transactions, for 1795, Part I.

38 *

gata are named numerically, according to the order in which they occur, beginning with the anterior. They also have other names, which generally are expressive of the functions of the different parts to which they are distributed.

Those which go to the nose are anterior to all the others, and are, therefore, denominated

The First Pair, or the Olfactory Nerves.

They arise by three delicate white fibres from the under and posterior part of the anterior lobes of the brain, being derived from the *Corpora Striata.* They proceed forward to the depression on the cribriform plate of the ethmoid bone, on each side of the crista galli. The upper surface occupies a small sulcus formed by the convolutions of the lower surface of the brain, and, therefore, has a longitudinal ridge on it. The lower surface is flat. Their texture is like that of the medullary part of the brain.

On each side of the crista galli each of them forms a pulpy enlargement of a brownish colour, which is called the *bulb*, and has been considered as a ganglion.

From this bulb many fine and delicate cords go off, which proceed through the dura mater and the foramina of the cribriform plate to the Schneiderian membrane.—These ramifications of the olfactory nerve seem to receive a coat from the dura mater, as they are much more firm after they have passed through it. They appear to be arranged in two rows as they proceed from the ethmoid bone—one running near to the septum, and the other to the opposite surface of the ethmoid bone.*

The Second Pair, or the Optic Nerves,

Originate from the *Thalami Nervorum Opticorum*, and appear on the external and lower surface of the brain, on each side of the sella turcica.

Each of them seems like a chord of medullary matter enclosed in a coat derived from the pia mater, and has not the fasciculated appearance of the other nerves. The medullary matter,

* See Fig. 91, page 439.

however, appears to be divided by processes that pass through it, which are derived from the coat of the nerve.

They proceed obliquely forward and inward, on each side of the sella turcica, in contact with the brownish cineritious substance, in which the infundibulum and the corpora albicantia of Willis are situated.* Anterior to this substance they come in contact with each other, and again separate, in such a way, that it is an undecided question whether they decussate each other, or whether each forms an angle, and is in contact with the other at the angle.

From this place of contact, each nerve proceeds to its respective foramen opticum, where it receives a coat from the dura mater, which extends with it to the eye, as has been described in the account of that organ.

The Third Pair of Nerves

Are sometimes called *Motores Oculorum*, in consequence of their distribution to several muscles of the eye. They arise at the inside of the crura cerebri, and make their appearance on the basis of the brain, at the anterior part of the pons Varolii.

They originate by numerous threads, which soon unite so as to form a cord, which passes through the dura mater, on each side of the posterior clinoid process, and continues through the cavernous sinus, and the foramen lacerum, to the orbit of the eye.

Before this nerve enters the orbit it generally divides into two branches which are situated one above the other. The *Uppermost Branch* is spent principally upon the rectus superior muscle of the eye, but sends a twig to the levator palpebræ. The *Inferior Branch* is distributed to two of the recti muscles, viz. the internus and the inferior, and also to the inferior oblique. It likewise sends a twig to a small ganglion in the orbit, called the *Lenticular* or *Ophthalmic Ganglion*,† from which proceed the fine nervous fibres that perforate the sclerotic coat.‡

* See vol. ii. page 352.

† This ganglion, which is considered as the smallest in the body, lies on the outside of the optic nerve, near its entrance into the orbit, and is generally surrounded by soft adipose matter.

‡ See vol. ii. page 381.

The Fourth Pair of Nerves,

Are called *the Pathetic*, in consequence of the expression of the countenance produced by the action of the muscle on which they are spent. They arise from the side of the valve of the brain, below and behind the Tubercula Quadrigemina,* and are so small that they appear like sewing thread. They proceed round the crura of the cerebrum, and appear on the surface between the pons Varolii and the middle lobes of the brain. They proceed along the edge of the tentorium, which they perforate, and passing through the upper part of the cavernous sinus, enter the orbit by the foramina lacera. They are exclusively appropriated to the *Superior Oblique*, or *Trochlearis* muscle.

The Fifth Pair of Nerves

Are called *Trigeminus*, because each nerve divides into three great branches.

These nerves arise from the crura of the cerebellum, where they unite to the pons Varolii by distinct fibres, which are connected so as to form a cord or nerve, that is larger than any other nerve of the brain. In many subjects this cord seems partially divided into two portions, the anterior of which is much smaller than the posterior, and appears softer at its origin.

It passes into a short canal formed by the dura mater, near the anterior extremity of the petrous portion of the temporal bone, at a small distance below the edge of the tentorium. It is perfectly loose and free from adhesion to the surface of this canal; but it soon passes out of it under the dura mater, and then adheres to that membrane. After leaving the canal, it expands like a fan, but still consists of fine fibres, which have some firmness. It is said that there are seventy or eighty of these fibres in the expansion, but they appear to be more numerous. Round the circumference of the expansion is a substance of a brownish colour, into which the fibres enter. This is the *Semilunar Ganglion*, or the *Ganglion of Gasser*, and from it the three nerves go off.

* See vol. ii. page 356.

These nerves pass off from the convex side of the ganglion, and are denominated the *Ophthalmic*, the *Superior Maxillary*, and the *Inferior Maxillary*.

The Ophthalmic Nerve

Passes into the orbit of the eye through the foramen lacerum: it there divides into several branches, which are called, from their distribution, *the Frontal* or *Supra Orbitar*, *the Nasal* and *the Lachrymal.*

The *Frontal* or *Supra Orbitar* branch proceeds forward in the upper part of the orbit, exterior to the membrane which lines it, and divides into two ramifications. One of these is small, and passes out of the orbit near the pulley of the superior oblique, to be spent upon the orbicularis muscle and the contiguous parts.

The other ramification passes through the supra orbitary foramen, or through the notch, which is in the place of that foramen, and divides into a number of twigs, some of which pass transversely towards the side of the head, and communicate with twigs from the portio dura. Most of the others extend upwards on the head. Some are distributed to the anterior part of the occipito-frontalis muscle, and the integuments of the forehead; others are spent upon the upper portion of the scalp. Some of the extreme parts of these ramifications also communicate with the portio dura.

The *Nasal Branch* proceeds obliquely forward towards the inner side of the orbit, and sends a twig, in its course, to the lenticular ganglion. It also sends off some small twigs, to join the ciliary nerves which go from the ganglion. On the inside of the orbit, a branch leaves it, which proceeds through the *Foramen Orbitare Internum Anterius* to the cavity of the cranium, and passes a small distance upon the cribriform plate of the ethmoid bone, under the dura mater, to a fissure in the said plate near the crista galli, through which it proceeds into the cavity of the nose. Here it divides into twigs, some of which pass on the septum near its anterior edge, and terminate on the integuments at the end of the nose, while others pass down on the inferior turbinated bone.

After parting with the ramifications to the nose, the remainder

of the nasal branch continues to the internal canthus of the eye, and sends twigs to the lachrymal sac, the caruncula lachrymalis, the eyelids, and the exterior surface of the upper part of the nose.

The *Lachrymal Branch* proceeds obliquely forward and outwards, towards the lachrymal gland. In its course, it sends off a twig, which passes through the spheno-maxillary fissure, and communicates with a twig of the upper maxillary nerve, and one or more twigs that pass to foramina in the malar bone. The main branch passes to the lachrymal gland, and some twigs continue beyond it to the contiguous parts.

The Superior Maxillary Nerve.

The second branch of the fifth pair is examined with great difficulty on account of its peculiar situation. It proceeds from the semilunar ganglion, and passes through the foramen rotundum of the sphenoid bone into the upper part of the zygomatic fossa. In this situation it sends a twig to the orbit by the spheno-maxillary fissure, and a branch, called the *Infra Orbitar*, which appears like the main nerve, as it preserves a similar direction, to the infra orbitar canal. At the same place it sends downwards two branches, which unite together almost immediately after their origin, and, as soon as they have united, enlarge into a ganglion.* The ganglion is called the *Spheno-Palatine*, or *Ganglion of Meckel.* It is rather of a triangular figure, and lies very near the spheno-palatine foramen. It gives off a posterior branch, which passes through the pterygoid foramen to the cavity of the cranium: some branches which proceed through the spheno-palatine foramen to the nose, and are called the *Spheno-Palatine* or *Lateral Nasal Nerves*: and an inferior branch that proceeds through the posterior palatine canal, and is called the *Palatine Nerve.*

The small branch, which was *first* mentioned, as going to the orbit by the spheno-maxillary fissure, divides into two ramifications. One of them unites with a twig of the lachrymal branch above mentioned, and passes out of the orbit, through a foramen

* Sometimes a single branch passes downwards instead of two; but it forms a ganglion in the same place.

in the malar bone, to the face, where it is distributed. The other passes also through a foramen of the malar bone, into the temporal fossa, and, after uniting with twigs from the *Inferior Maxillary Nerve*, proceeds backwards and perforates the aponeurosis of the temporal muscle, to terminate on the integuments of the temporal region.

Before the *Infra Orbitar* branch enters the canal of that name, it sends off two twigs, called *Posterior Dental Nerves*, which pass downwards on the tuberosity of the upper maxillary bone, and enter into small canals in that bone, that are situated behind the antrum maxillare. They subdivide into fine twigs that proceed forward to the alveoli of three or four of the last molar teeth, and penetrate each of the roots by a cavity at its extremity. Twigs also proceed from these nerves to the posterior part of the gums and buccinator muscle.

After the posterior dental nerves have left it, the *Infra Orbitar* nerve proceeds forwards in the canal of that name; and near the extremity of it, gives off the anterior dental nerve, which accompanies it for some distance, and then proceeds downwards in a canal in the bone anterior to the antrum maxillare. In its course this nerve divides into many fibres, which pass to the roots of the incisor, canine, and small molar teeth, each in its proper canal. These dental branches sometimes pass in the antrum maxillare between the lining membrane and the bones. The *Infra Orbitar* nerve passes out of the foramen upon the cheek, and divides into several branches of considerable size, which are distributed on the face from the side of the nose to the back of the cheek, and also upon the under eyelid and the upper lip.

The *Pterygoid Nerve*, or posterior branch, passes backwards, from the ganglion to a canal in the base of the pterygoid process of the os sphenoides, and proceeds through it. After leaving this canal, it passes through a substance almost as firm as cartilage, which closes the anterior foramen lacerum, at the basis of the cranium, and divides into two branches. The smallest of them, called the *Vidian Nerve*, proceeds with a small artery to the small foramen, or Hiatus Fallopii, on the anterior side of the

petrous portion of the temporal bone, and continues, through a small canal, to join the portio dura of the seventh pair in the larger canal, called the *Aqueduct of Fallopius*, at the first turn in that canal.* The other branch of the pterygoid nerve proceeds to the foramen caroticum, and passes through it, with a twig of the sixth pair, to join the first cervical ganglion of the *Intercostal Nerve.*

The *Spheno-Palatine, or Lateral Nasal Nerves*, consist of several branches which pass from the spheno-palatine ganglion through the spheno-palatine foramen into the nose. Some of them are distributed to that part of the pituitary membrane, which is above the upper meatus, and others to the part which is immediately below it. Some of the branches which thus enter the nose are spread upon the septum; one among them extends upon it, downwards and forwards, to the anterior part of the palatine process of the upper maxillary bone, where it enters into the foramen incisivum, and terminates in a papilla in the roof of the mouth.†

The *Palatine Branch* proceeds through the canal formed by the upper maxillary and palate bones, to the roof of the mouth and soft palate. Soon after its origin, it sends off a twig which proceeds down a small canal that is behind it. It also sends off, as it proceeds downwards, several twigs to that part of the membrane of the nose which covers the inferior turbinated bone. When it arrives at the roof of the mouth, it divides into several branches which run forwards, and are distributed to the membrane which lines the roof of the mouth. Some of its branches pass to the soft palate, the uvula, and the tonsils; small filaments pass into the back part of the upper jaw.

* The late Mr. John Hunter believed that this nerve parts from the portio dura at the lower end of the aqueduct, and is the chorda tympani.

† The curious distribution of this nerve appears to have been known to the late John Hunter, and also to Cotunnius; but it is minutely described by Scarpa, and is delineated by Sömmering in his plate of the nose.—See "Observations on certain parts of the Animal Economy," by J. Hunter, page 219, and also Scarpa "De Organo Olfactus." In this last are some interesting observations relative to the ducts of Steno.

The Inferior Maxillary Nerve, or the Third Branch of the Fifth Pair,

Passes through the foramen ovale into the zygomatic fossa, and divides into *two branches*, one of which sends ramifications to many of the contiguous muscles, as the temporal, the masseter, the buccinator, the pterygoid; and, also, to the anterior part of the ear and the side of the head. The other branch passes between the pterygoid muscles, and divides into two ramifications, one of which proceeds to the tongue, and is called the *Lingual* or *Gustatory*, while the other passes into the canal of the lower jaw.

The *Lingual Nerve* proceeds between the pterygoid muscles, and, in its course, is joined by the chorda tympani. It continues forward between the maxillary gland and the lining membrane of the mouth; and passes near the excretory duct of that gland, above the mylo-hyoideus and the sublingual gland to the under side of the tongue, near the point: it then divides into a number of branches which enter into that body between the genio-hyoideus and lingualis muscles. This nerve has been supposed to be particularly concerned in the function of taste, because many of its branches continue to the upper surface of the tongue, especially near the point. In its course it has a communication with the ninth pair of nerves, and sends twigs to the membrane of the mouth and gums, and the contiguous parts.

After parting with the lingual nerve, the inferior maxillary continues to the upper and posterior orifice of the canal in the lower jaw. Before it enters this canal it sends a branch to the sub-maxillary gland, and to the muscles under the jaw. It then enters the canal, attended by blood-vessels, and proceeds along it to the anterior maxillary foramen, on the side of the chin, through which it passes out. In this course it sends twigs to the sockets of the teeth, and generally supplies all the large and one of the small grinders. Before it leaves the jaw it sends a branch forward, which supplies the remaining teeth on the side to which it belongs. After passing out, through the anterior foramen, it is

spent upon the muscles and integuments of the front of the cheek, the chin and the under lip.

The Sixth Pair of Nerves,

Are called *Motores Externi.* They arise from the commencement of the medulla oblongata, and proceed forward under the pons Varolii. They proceed through the dura mater on the inside of the fifth pair, and appear to pass through the cavernous sinuses, but are enclosed in sheaths of cellular membrane while they are in those sinuses. When in this situation they are near the carotid arteries, and each nerve sends off one or more very fine twigs, which being joined by a twig from the pterygoid branch of the fifth pair, accompany the carotid artery through the carotid canal, and then unite themselves to the upper extremity of the upper cervical ganglion of the intercostal nerve.

The sixth pair afterwards pass into the orbit of the eye, each through the foramen lacerum of its respective side, and is spent upon the *Rectus Externus* or *Abductor* muscle of the eye.

The Seventh Pair of Nerves

Comprises two distinct cords, which have very different destinations; and have, therefore, been considered as different nerves, by several anatomists. One of these cords is appropriated to the interior of the ear, and is the proper *Auditory Nerve.* The other is principally spent upon the face, and, therefore, has been called the *Facial.* They have, however, more frequently been denominated the *Seventh Pair*, and distinguished from each other, in consequence of a great difference in their texture, by the appellations of *Portio Dura* and *Portio Mollis.*

These two cords pass off nearly in contact with each other, from the side of the upper part of the *Medulla Oblongata*, where it is in contact with the pons Varolii; but the *Portio Mollis* can be traced to the fourth ventricle, while the *Portio Dura* is seen to rise from the union of the pons Varolii with the medulla oblongata and the crura cerebelli. The *Portio Dura*, at its origin, is on the inside of the *Portio Mollis.* Between these cords are

one or more small fibres, called *Portio Media*, which seem to originate very near them, and finally unite with the *Portio Dura*.

Each of the seventh pair of nerves, thus composed, proceeds from its origin to the meatus auditorius internus of the temporal bone; and the portio mollis divides into fasciculi, which proceed to the different parts of the organ of hearing in the manner described in the account of the ear.*

The *Portio Dura* enters an orifice at the upper and anterior part of the end or bottom of the *Meatus Auditorius Internus*. This orifice is the commencement of a canal, which has been called the *Aqueduct of Fallopius*, and proceeds from the *Meatus Auditorius Internus* to the external foramen, between the mastoid and styloid processes at the basis of the cranium. This canal first curves backwards and outwards, near to the upper surface of the petrous bone, then forms an acute angle, and proceeds, (backwards and downwards,) to the stylo-mastoid foramen, passing very near the cavity of the tympanum in its course.

The *Portio Dura*, as it passes into the canal from the meatus internus, seems to receive an investment from the dura mater. It fills up the canal, but does not appear to be compressed. Near the angle it is joined by the twig of the Vidian nerve, which proceeds from the pterygoid branch of the fifth pair, and enters the petrous bone by the small foramen innominatum on its anterior surface. In its course through the canal it sends off some very small twigs to the muscles and appurtenances of the small bones of the ear, and to the mastoid cells; and, when it has arrived almost at the end of the canal, it sends off in a retrograde direction, a small branch which proceeds into the cavity of the tympanum, (entering it by a foramen near the base of the pyramid,) and crosses the upper part of it, near the membrana tympani, between the long processes of the *Malleus* and *Incus*. This twig is the *Chorda Tympani;* it proceeds from the cavity by a fissure on the outside of the Eustachian tube, to join the lingual branch of the fifth pair, as has been already mentioned.†

* See vol. ii. p. 432.

† The late John Hunter believed that the chorda tympani is merely a continuation of the twig of the pterygoid branch which joins the portio dura above.—See Observations on certain parts of the Animal Economy, page 220.

The *Portio Dura*, after passing out of the *Foramen Stylo-Mastoideum*, is situated behind and within the parotid gland. Here it gives small twigs to the back of the ear and head, and to the digastric and stylo-hyoideus muscles. It perforates the gland after sending filaments to it, and then divides into branches which are arranged in such a manner that they constitute what has been called the *Pes Anserinus.*

To describe the various branches in this expansion would be more laborious than useful. Some of them are spread upon the temple and the upper part of the side of the head, and unite with the supra-orbitar branches of the ophthalmic nerve. Some pass above and below the eye, and are distributed to the orbicularis muscle, and communicate with nervous twigs that pass through foramina in the malar bone, &c. Some large branches pass transversely. These cross the masseter muscle, and divide into ramifications which are spent upon the cheek and the side of the nose and lips, and communicate with the small branches of the superior maxillary nerve.

A large number of branches pass downwards. Many of them incline forwards, and are spent on the soft parts about the under jaw; while others proceed below the jaw to the superficial muscles and integuments of the upper part of the neck, communicating with the branches of the contiguous nerves.*

The Eighth Pair of Nerves

Are very frequently denominated the *Par Vagum*, on account of their very extensive distribution.

They arise from those portions of the medulla oblongata which are denominated the *Corpora Olivaria.* Each nerve consists of a cord, which is anterior, and called the *Glosso-Pharyngeal;* and of a considerable number of small filaments, which arise separately, but unite and form another cord, the proper

* A most minute and laboured description of the nerves of the face was published by the celebrated Meckel, in the seventh volume of Memoirs of the Royal Academy of Sciences of Berlin, for the year 1751, accompanied with a plate, exhibiting the side of the head, of three times the natural size. This is republished in the Collection Academique: Partie Etrangére.—Tom. viii.

Par Vagum. Associated with these is a third cord, called the *Spinal* or *Accessory Nerve* of Willis, which originates in the great canal of the spine, and, passing up into the cavity of the cranium, goes out of it with these nerves through the foramen lacerum.

The two first mentioned nerves proceed from their origin to the posterior foramen lacerum, and pass through it with the *Internal Jugular* vein,—being separated from the vein by a small process of bone. They are also separated from each other by a small process of the dura mater. In the foramen they are very close to each other; but soon after they have passed through it, they separate and proceed towards their different destinations.

The *Glosso-Pharyngeal* proceeds towards the tongue, between the stylo-pharyngeus and the stylo-glossus muscles, following the course of the last mentioned muscle to the posterior part of the tongue. At the commencement of its course it receives a twig from the *Portio Dura*, and one also from the *Par Vagum.* It soon gives off a branch which passes down on the inside of the common carotid to the lower part of the neck, where it joins some twigs of the intercostal to form the cardiac nerves. Afterwards it sends off several twigs to the muscles of the pharynx and its internal membrane, and also some twigs which unite with others from the upper cervical ganglion of the *Sympathetic*, and form a network that lies over the anterior branches of the external carotid. The *Glosso-Pharyngeal* finally enters the tongue, at the termination of the hyo-glossus muscle; and after sending branches to the lingualis, and the various muscles inserted into the tongue, terminates in small ramifications that are spent upon the sides and middle of the root of the tongue, and upon the large papillæ.

The Par Vagum

Are slightly enlarged after passing through the foramen lacerum. As they descend, they adhere to the superior ganglion of the intercostal, and also to the ninth pair. They proceed behind and on the outside of the carotid, and are contained in the same sheath of cellular membrane which encloses that artery and the

internal jugular vein. Each of these nerves, soon after it leaves the cranium, gives a twig to the glosso-pharyngeal; soon after that it sends off a branch called the *Pharyngeal*, which unites to one from the accessory nerve, and to one or more from the glosso-pharyngeal, and proceeds to the middle constrictor of the pharynx, when it expands into ramifications that form a plexus from which proceed a number of small twigs that go to the larynx, and some that pass down on the common carotid artery.

It then sends off, downward and forward, the *Superior Laryngeal* nerve, which continues in that direction behind the carotid artery, and divides into an external and internal branch.

The *Internal Branch*, which is the largest, proceeds between the os hyoides and the thyroid cartilage; and divides into numerous ramifications which are distributed to the arytenoid muscles and to the membrane which lines the larynx and covers the epiglottis. It is said that fine twigs can be traced into the foramina, which are to be seen in the cartilage of the epiglottis;—some ramifications can be traced to the pharynx;—others communicate with the branches of the recurrent nerve.

The *External Branch* sends twigs to the pharynx, to the lower and inner part of the larynx, and to the thyroid gland.

In its course downwards, the great nerve sometimes sends off a twig, which unites with one from the ninth pair that passes to the sterno-hyoidei and sterno-thyroidei muscles.

It uniformly sends off one or more twigs, which pass into the thorax and combine with small branches from the sympathetic or intercostal nerve, to form the *Cardiac plexus*, which sends nerves to the heart.

After entering the thorax, the right trunk of the *Par Vagum* passes before the subclavian artery; and the left trunk before the arch of the aorta; and immediately after passing these arteries, each of the nerves divides into an anterior and posterior branch. The anterior is the continuation of the *Par Vagum;* the posterior is a nerve of the *Larynx;* which from its retrograde course, is called the *Recurrent Nerve.*

On the left side the *Recurrent Nerve* winds backwards round

the aorta, and, on the right side, round the subclavian artery, and proceeds upwards, deeply seated, on the side of the trachea, to the *Larynx.* Soon after its origin it sends filaments to a ganglion of the sympathetic, to the cardiac plexus, and to a pulmonary plexus, soon to be mentioned. In its course upwards, it sends twigs to the trachea and the œsophagus. It proceeds behind the thyroid gland, and sends twigs to that organ. At the lower part of the larynx it sends off a branch which communicates with branches of the superior laryngeal nerve. It also divides into branches which are spread upon the posterior crico-arytenoid, and the arytenoid muscles; and also upon the lateral crico-arytenoid and the thyreo-arytenoid muscles, as well as upon the membrane which lines the back part of the larynx and the contiguous surface of the pharynx.

There is a difference in the arrangement of the recurrents on the different sides, in consequence of one winding round the aorta, while the other winds round the subclavian artery.

After sending off the recurrents, each trunk of the *Par Vagum* proceeds behind the ramifications of the trachea; but previously detaches some small branches, which are joined by twigs from the intercostal and from the recurrent, and form a plexus upon the anterior part of the vessels going to the lungs. This *Anterior plexus,* after sending off some minute branches to the cardiac nerves and the pericardium, transmits its branches with the bronchia and the blood-vessels, into the substance of the lungs.

Some of the branches which proceed from the par vagum, pass down on the posterior part of the trachea, and enter into the membrane which forms it, and the mucous glands which are upon it; and some pass to the œsophagus.

When the par vagum is behind the great vessels of the lungs, a number of branches go off transversely, and are also joined by some fibres from the sympathetic. These form the *Posterior pulmonary plexus;* the ramifications from which proceed into the substance of the lungs, and are principally spent upon the ramifications of the bronchia. It has been said,* that the small twigs into which they divide, very generally penetrate into the

* See Buisson, in the continuation of the Descriptive Anatomy of Bichat.

small ramifications of the bronchia, and are spent upon their internal membrane.

Soon after sending off the nerves of the pulmonary plexus, the *Par Vagum* proceeds downwards upon the œsophagus; the left nerve being situated anteriorly, and the right posteriorly. Each of these nerves forms a plexus so as nearly to surround the œsophagus, as they descend on it; but the network is thickest on the posterior side. They pass through the diaphragm with the œsophagus, and unite again so as to form considerable trunks.

The *Anterior*, which is the smallest, proceeds along the lesser curvature of the stomach to the pylorus. Some of its fibres are spread upon the anterior side of the stomach and the lesser omentum. Others of them extend to the left hepatic, and also to the solar plexus.

The *Posterior* trunk sends branches to surround the cardiac orifice of the stomach. Many branches are spread upon the under side of the great curvature of the stomach. Some of them pass in the course of the coronary artery to the cœliac, and unite to the hepatic and splenic plexus; and one trunk, which is thick, although short, proceeds to the solar plexus.

The Accessory Nerve of Willis,

Which has been mentioned as associated with the eighth pair of nerves, within the cranium, has a very peculiar origin.

It arises by small filaments, which come off from the spinal marrow, between the anterior and posterior fasciculi of the cervical nerves, and proceeds upwards to the great occipital foramen, between these fasciculi. It commences sometimes at the sixth or seventh cervical vertebra, and sometimes about the fourth. It enters the cavity of the cranium through the foramen magnum, and proceeds upwards and outwards, so as to join the eighth pair of nerves at some distance from its origin, and in this course it receives filaments from the medulla oblongata.

After approaching very near to the eighth pair of nerves, it accompanies it to the foramen lacerum, and passes out in its own separate sheath. It then leaves the eighth pair and descends towards the shoulder, proceeding through the sterno-mastoid

muscle. Soon after it emerges from the cranium, it sends a ramification to the pharyngeal branch of the *Par Vagum* and another to the *Par Vagum* itself. After passing through the upper and back part of the sterno-mastoid muscle it terminates in the trapezius. It adheres to the ninth pair of nerves as it passes by it, and sends a twig to the sub-occipital and some of the cervical nerves. It also gives ramifications to the sterno-mastoid muscle as it passes through it.

It has already been stated that the Laryngeal and Recurrent Nerves appear to answer different purposes in their distribution to the Larynx. When both of the recurrent nerves are divided in a living animal, the voice seems to be lost. When the laryngeal nerves only are divided, the strength of the voice remains, but it is flatter. The recurrent nerves, therefore, seem essential to the formation of the voice. The laryngeal nerves are necessary to its modulation.

The history of the investigation of this subject is contained in Mr. Haighton's paper in the third volume of Memoirs of the Medical Society of London.

The Ninth Pair of Nerves.

Each of these nerves arises from the groove in the medulla oblongata, between the corpora pyramidalia and the corpora olivaria. Three or four fasciculi, of distinct filaments, unite to form it. Thus composed, it proceeds to the anterior condyloid foramen of the occipital bone, and passes through the dura mater. It seems firmly united, by the cellular membrane, to the eighth pair, and to the first ganglion of the sympathetic, soon after it passes from the occipital bone. It is either connected to the sub-occipital nerve by a small ramification, or it joins a branch which proceeds from the sub-occipital to the cervical, and bends round the transverse process of the atlas. It passes between the internal carotid artery and the internal jugular vein, and crosses the external carotid at the origin of the occipital artery. At this place it generally sends downwards a large branch which is called the *Descendens Noni.* Passing forwards, it is on the outside of the posterior portion of the digastric muscle, and inclines downwards; but near the tendon of the

muscle it turns upwards, and proceeds on the inside of the mylo-hyoideus, where it divides into ramifications, which, at the anterior edge of the hyo-glossus muscle, begin to enter into the substance of the tongue, between the genio-glossus and the lingualis muscles.

Some of the branches of this nerve unite with those of the lingual branch of the fifth pair. Others are distributed to almost all the muscles connected with the tongue.

The branch called *descendens noni* passes down in the course of the common carotid artery, and sends branches in its progress to the upper portions of the coraco-hyoid and sterno-thyroid muscles; it unites with ramifications of various sizes from the first, second, and third cervical nerves, which form a bow under the sterno-mastoid muscle, from which ramifications go to the lower portions of the sterno-hyoid and thyroid muscles, and of the coraco-hyoid.

Of the Cervical Nerves.

The tenth or last pair of the head, commonly called the *Sub-occipital*, may be arranged with these nerves, because they arise, like them, from the medulla spinalis, and are distributed to the muscles on the neck.

The Sub-occipital Nerves

Arise on each side of the spinal marrow, nearly opposite to the interval between the great foramen of the os occipitis and the atlas.

Each of these nerves consists of an anterior and posterior fasciculus, or bundle of fibres, which pass outwards immediately under the vertebral arteries, and form a ganglion, from which proceed an anterior and a posterior branch.

The anterior branch is united to the second cervical nerve below, and to the ninth nerve, or the hyoglossal, above. It also sends filaments to the upper ganglion of the great sympathetic nerve.

The posterior branch is spent upon the *Recti*, the *Obliqui*, and some other muscles of the head.

The *proper Cervical Nerves* consist of *seven pairs;* of which the first six go off between the vertebræ of the neck, and the seventh between the last of the neck and the first of the back.

The First Cervical Nerve

Passes out between the atlas and the *Vertebra Dentata.* It originates from two fasciculi, which are connected to each other at a ganglion, and then separate into an anterior and a posterior branch.*

The anterior branch is connected by filaments with the accessory nerve, with the ninth pair of the head, and with the upper ganglion of the sympathetic. It is also connected with the second cervical nerve, and sends some branches to the muscles on the anterior part of the spine.

The posterior branch, after communicating with the posterior branches of the sub-occipital and the second nerves of the neck, perforates the complexus muscle, and ascending upon the back of the head, is distributed with the occipital artery.

The Second Cervical Nerve

Sends off, from its *Anterior Branch*, a twig which descends to the lower cervical ganglion of the sympathetic, and a considerable ramification to the third cervical nerve. It also sends off some twigs to the sterno-mastoid muscle, and others to join the accessory nerve. Some of its small ramifications pass down upon the external jugular vein, and others unite with the descending branch of the ninth pair of the head. A small branch is also concerned in the formation of the phrenic nerve. Two larger branches of this nerve wind round the posterior edge of the sterno-mastoid, and are spread under the integuments of the anterior, lateral, and posterior parts of the neck and lower parts of the head; they have a communication with the portio dura of the seventh pair.† The posterior branch of this nerve is spent upon the extensor muscles of the head and neck.

* This arrangement is common to the nerves of the spine. The ganglion is formed by the posterior fasciculus.

† These superficial branches have sometimes been described as coming from a plexus; but they often arise directly from the second cervical nerve.

The Third Cervical Nerve

Sends down, from its *Anterior Branch*, the principal trunk of the phrenic nerve. It also sends twigs to the fourth cervical, to the lower cervical ganglion of the intercostal, and to the descending branch of the ninth of the head. Some of its branches unite with twigs of the accessory nerve, and others are spent upon the muscles and integuments of the shoulder and lower part of the neck. A small *Posterior Branch* is spent upon the muscles of the back of the neck.

The Nerves of the Diaphragm

Are generally denominated the *Phrenic.* The principal root of each of them is commonly derived from the third cervical nerve, but frequently the second and the fourth cervical nerves contribute to the formation; and they are sometimes joined by a twig which is derived from the ninth pair.

Each nerve proceeds down the neck, between the rectus capitis major and the scalenus anticus, and continues along the fore part of the scalenus anticus; it descends into the thorax within the anterior end of the first rib, between the subclavian vein and the artery. It sometimes receives a twig from the fifth cervical nerve, and a twig passes between it and the great sympathetic. After entering the thorax, they descend, attached to the mediastinum, before the root of the lungs. In consequence of the projection of the point of the heart to the left, the course of the left is a little different from that of the right; that of the right proceeding in a more perpendicular direction. When they arrive at the diaphragm, they divide into many ramifications, which have a radiated arrangement, and terminate on the fibres of that muscle, both on the upper and lower surface. Some fibres from each nerve are continued downward, and communicate in the abdomen with fibres from the intercostal.

The Fourth, Fifth, Sixth, and Seventh Cervical Nerves

May be comprised in one description. They pass off successively from the medulla spinalis, between the vertebræ, like the

other nerves. Their *Posterior Branches* are generally distributed to the back of the neck, and are very small. Their *Anterior Branches* are principally appropriated to the upper extremities, and are large. They generally send each a small twig to the lower cervical ganglion of the intercostal nerve, and a few small branches to some of the contiguous muscles. They are arranged and combined so as to form the net-work, now to be described, which is called the *Brachial* or *Axillary plexus;* and, in the formation of this plexus, they are joined by the first dorsal nerve.

The Brachial Plexus

Extends from the lower part of the side of the neck into the arm-pit. It commences in the following manner. The fourth and fifth cervical nerves proceed downwards, and after uniting to each other about an inch and a half below their egress from the spine, they separate again, almost immediately, into two branches.

The sixth cervical nerve, after passing downwards, divides also into two branches, one of which unites with the uppermost branch that proceeds from the union of the fourth and fifth, and the other with the lowermost, and they all proceed downwards.

The seventh cervical is joined by the first dorsal, which proceeds upwards, and unites with it at a short distance from the spine. The cord produced by their junction soon unites with one of the cords above described. As these different cords proceed downwards, they divide, and their branches again unite. The axillary artery, which passes in the same direction, is surrounded by them. In this manner the axillary plexus is often formed.

The muscles about the shoulder, both before and behind, are supplied by the axillary plexus. Thus, it sends branches to the *Sub-scapularis, Teres Major*, and *Latissimus Dorsi*, behind; and to the *Pectoralis Major* and *Minor*, and the *Mamma*, before. It also sends off a branch called the *Scapularis*, which commonly arises from the upper part of the plexus, and proceeds through the notch in the upper costa of the scapula to the supra and infra spinatus, teres minor, &c.

Nerves of the Arm.

All the great nerves of the arm are derived from the axillary plexus. There are six of them, which are denominated *The Musculo-Cutaneus; The Median;** *The Cubital*, or *Ulnar; The Internal Cutaneus; The Radial* or *Muscular Spiral;* and the *Circumflex* or *Articular.*

The *Musculo-Cutaneus*, or *Perforating Nerve*, passes obliquely through the upper part of the coraco-brachialis muscle. Before it enters the muscle, it sends a branch to it. After leaving the muscle it passes down the arm between the biceps and the brachialis internus, to which it also gives branches. It proceeds to the outside of the biceps, and continues under the median cephalic vein to the anterior and external part of the fore-arm; along which it passes under the integuments. On the lower part of the fore-arm it divides into many branches, which extend to the root of the thumb and the back of the hand, and terminate in the integuments.

The Median Nerve, which is one of the largest of the arm, often proceeds from the axillary plexus next to the musculo-cutaneus; it passes down the arm, very near the humeral artery, within the edge of the biceps flexor muscle, and, during this course, gives off no branches of any importance. After passing the bend of the elbow, it proceeds under the aponeurosis of the biceps, between the brachialis internus and the pronator teres, and continues down near the middle of the fore-arm, between the flexor sublimis and the flexor profundis. At the elbow it sends branches to several muscles on the anterior side of the fore-arm, and to the integuments. Among these branches is one, called the *Interosseal Nerve*, which passes down on the anterior surface of the interosseal ligament, with the artery of that name. This nerve sends branches, in its course, to the long flexor of the thumb, and the deep flexor of the fingers. When it arrives at the pronator quadratus, it sends branches to that muscle, and, passing between it and the interosseus ligament,

* Sometimes called Brachial.

perforates the ligament, and soon terminates on the posterior side of the wrist and hand.

As the *Median Nerve* proceeds downwards, it becomes more superficial; and continuing among the tendons of the flexors of the fingers, it gives off a branch which is principally spent upon the integuments of the palm of the hand. This great nerve passes with the tendons under the annular ligament; and immediately after, while it is covered by the *Aponeurosis Palmaris*, and by that portion of the artery which is called *Arcus Sublimus*, it divides into branches, which separate from each other at acute angles, and subdivide so as to send a ramification to each side of the thumb, of the index, and of the middle finger; and to the radial side of the ring finger.

The *Cubital* or *Ulnar Nerve* is also of considerable size. It passes down on the inside of the triceps extensor muscle, to the great groove formed by the olecranon process and the internal condyle of the os humeri; and, in this course, it often sends a branch to the triceps, and some smaller twigs to the upper part of the fore-arm. From the groove it proceeds on the anterior part of the fore-arm, between the flexor carpi ulnaris and the flexor sublimis, to the wrist. At a small distance above the wrist it sends off a branch, called the *Dorsalis*, which passes between the flexor ulnaris and the ulna, to the back of the fore-arm and wrist, where, after sending ramifications to the integuments and contiguous parts, it divides into branches which pass to the little finger and the finger next to it. Those branches send off, in their course, many twigs which pass to the skin and cellular substance.

The ulnar nerve then proceeds with the artery, over the annular ligament, on the radial side of the os pisiforme, and divides into two branches; one of which is superficial, and the other deep-seated.

The *Superficial* divides into two principal branches, an external and an internal. The external passes under the aponeurosis palmaris; and, after sending a branch to combine with one from the median and some twigs to the contiguous muscles, it subdivides into two branches, one of which goes to the ulnar side of

the ring finger and the opposite side of the little finger. The other branch sends off some twigs to the muscles, and proceeds along the ulnar side of the little finger.

The *Deep-seated* palmar branch of the ulnar nerve passes between the muscles of the little finger, under the tendons of the flexors, and accompanies the deep-seated arterial arch in the palm of the hand, giving branches to the interossei, and other contiguous muscles.

The *Radial* or *Muscular Spiral* nerve is one of the largest nerves of the arm. It passes from the axillary plexus downward, backward, and outward, under the triceps muscle to the external side of the os humeri. In this course, it gives off several branches to the different portions of the triceps. It also frequently gives off a large branch, which passes downwards on the outside of the olecranon, to the back of the fore-arm, and continues to the back of the hand, furnishing many branches which terminate in the integuments. It then proceeds downwards between the supinator radii longus and the brachialis internus. Immediately after passing the articulation of the elbow, it divides into two branches, denominated the *Superficial* and the *Profound*. The *Superficial* soon joins the radial artery, and proceeds downwards, sending branches to the contiguous muscles. In its course about the middle of the arm it crosses the tendon of the supinator longus, and proceeds between it and the tendon of the extensor carpi radialis longior; it soon after divides into two branches, which are principally distributed to the thumb and fore-finger, and also to the integuments.

The *Profound* branch proceeds to the back of the fore-arm under the radial extensor, and continues to the back of the wrist and hand. In this course it divides into two branches, which are distributed to the contiguous muscles and tendons, and the integuments.

The *Internal Cutaneus* nerve is the smallest of the nerves which proceed from the axillary plexus. It descends in the course of the basilic vein, and very near it. Above the elbow it divides into an *Internal branch*, which proceeds over the *Basilic Vein*, and separates into branches that pass down on the side of the fore-arm; and an *External Branch* that passes under the

Median Basilic Vein, and continues down on the anterior part of the fore-arm.

The *Articular* or *Circumflex* nerve proceeds backwards from the plexus, between the teres major and minor, and passes nearly around the body of the os humeri, at a small distance below its head. It is distributed to the contiguous muscles and to the articulation; but its principal branches terminate in the deltoid muscle.

The Dorsal Nerves

Proceed from the cavity of the spine between the dorsal vertebræ. They are sometimes called *Intercostals*, because they pass between the ribs, like the blood-vessels of that name. There are twelve pairs of them, and they are named numerically, beginning from above.

These nerves proceed from the medulla spinalis by two fasciculi of fibres—one from each of its lateral portions—the posterior fasciculus is the largest. After passing through the lateral foramen and the dura mater, a ganglion is formed by the posterior fasciculus: the anterior fasciculus unites to this ganglion at its external extremity; and one nerve is formed, which almost immediately divides into an anterior and a posterior branch, of which the anterior is the largest.

The posterior branch proceeds backwards, and is distributed to the muscles of the back. The anterior branch passes towards the angle of the rib, in contact with the pleura. Soon after its origin, this anterior branch sends off two ramifications which unite to the intercostal nerve, at the ganglion; it then proceeds forwards with the blood-vessels, between the internal and external intercostal muscles, in the groove near the lower margin of the ribs; and terminates on the anterior part of the thorax. In its course it sends branches, not only to the intercostal muscles and pleura, but to the other muscles and the integments of the thorax.

Some of the dorsal nerves differ from the others, as to the ramifications which they send off.

The *first nerve*, of this order, joins the lower cervical nerves

in the axillary plexus; but it sends off the ramifications to the sympathetic, and also a branch, which passes under the first rib, like the other dorsal nerves.

The *second nerve* sends off a branch, which passes through the external intercostal muscle into the axilla, and combines there with a branch of the cutaneous nerve, being distributed to the internal and posterior part of the arm.

The third dorsal nerve also sends off a branch, which is distributed to the axilla and the back part of the arm.

These branches of the second and third dorsal nerves, are called intercosto-humeral nerves.

The lower dorsal nerves supply the muscles and integuments of the abdomen.

Of the Lumbar Nerves.

There are five pairs of these nerves. The first of them passes off between the first and second of the lumbar vertebræ, and the others succeed regularly; so that the last pair is situated between the last lumbar vertebra and the sacrum.

The first lumbar nerves arise from the medulla spinalis, before it forms the cauda equina; the other four pair are formed by the cauda equina.

They commence by anterior and posterior fasciculi, which are united at a ganglion. From this ganglion, anterior and posterior branches go off, which are very different in size, the anterior being the largest.

The posterior branches are distributed to the muscles of the back. The anterior send branches to the ganglions of the sympathetic nerve, and also communicate with each other to form the *Lumbar Plexus*, which is situated on the lateral parts of the bodies of the lumbar vertebræ, before their transverse processes, and supplies nerves to the muscles of the thigh.

The First Lumbar Nerve

Is connected, by its anterior branch, to the last dorsal and the second lumbar. From the same branch ramifications go off to the Quadratus Lumborum, and obliquely across that muscle, to

the lower part of the abdominal muscles near the spine of the ilium.

The Second Lumbar Nerve

Sends off a muscular branch downwards and outwards: it also sends off the small branch, called the *External Spermatic*, which passes down in such a direction, that it perforates the transversalis and the obliquus internus muscles, near their lower margin, at a small distance from the superior anterior spine of the ilium, and then proceeds within the lower edge of the tendon of the external oblique to the abdominal ring, through which it passes. In the male it is distributed to the spermatic cord and scrotum, and in the female to the labia pudendi. In the female it also sends a branch to the uterus.* The *Second Lumbar*, after sending off these branches, passes downwards, and joins the *Third* lumbar nerve. From this union of the second and third nerves, a branch called the *Cutaneus Medius*, which will be soon described, proceeds downwards.

After sending off this branch, the united trunk of the second and third joins the *Fourth;* and from this union is sent off the *Obturator Nerve*, which passes through the aperture in the membrane that closes the foramen thyroideum; the *Crural Nerve*, which passes under Poupart's ligament; and a *third branch* that proceeds downwards, and joins the *Fifth* lumbar nerve. The *Fifth* lumbar nerve, with this accession from above, descends into the pelvis, and unites with the sacral nerves.

This arrangement of the lumbar nerves constitutes the *Lumbar Plexus*, which, as has been already stated, furnishes three nerves to the lower extremity, namely, the *Cutaneus Medius*, the *Obturator*, and the *Crural Nerve.*

The *Cutaneus Medius*, which arises from the union of the second and third nerves, as has been already observed, proceeds downwards, and frequently adheres to the crural nerve, for a short distance, near Poupart's ligament, but soon leaves it, and descends on the inside of the thigh, supplying the integuments as low as the knee.

* The external spermatic often comes off from the first lumbar nerve.

The Obturator Nerve

Descends into the pelvis, and passes out of it at the upper part of the foramen thyroideum; proceeding downwards in an internal direction, to be distributed on the inside of the thigh.

This nerve is generally accompanied by the obturator artery and vein: the artery being above, and the vein below it. When it has arrived at the foramen ovale or thyroideum, it sends off a branch to the internal and external obturator muscles, and, after passing these muscles, divides into two branches, which are distributed to the muscles on the inside of the thighs, the adductors, the pectineus, the gracilis, &c.

The Crural Nerve

Is situated at first behind, and then on the outside of the psoas muscle. It passes under Poupart's ligament with the great femoral vessels, being on the outside of the artery.

It is distributed to the integuments, and also to the muscles, which are situated on the anterior and internal parts of the thigh. Some of its ramifications go off before it passes under Poupart's ligament. Several of them are spent upon the integuments, and are, therefore, denominated *Cutaneus.*—They are distinguished by the terms *Cutaneus Anterior, Cutaneus Internus,* &c., according to their situations.

The deep-seated branches are the largest. They are principally spent upon the muscles on the anterior and the internal side of the thigh, namely, the four extensors, the adductors, the pectineus, the sartorius and the gracilis. Among these nerves there is one, called the *Saphenus*, which has a different destination. It accompanies the great artery of the thigh to the place where it perforates the *Adductors;* it there separates from the artery, and passes over the tendon of the *Adductors*, under the sartorius muscle; thence it continues, with the great saphena vein on the inside of the leg, to the internal ankle; sending branches to the integument, in its course. It terminates in skin and cellular substance on the upper and internal surface of the foot.

The Sacral Nerves

Are composed of those cords of the cauda equina which remain after the formation of the lumbar nerves. They are frequently stated to consist of five or six pairs, four of which pass through the foramina of the sacrum, and the fifth between the sacrum and the os coccygis.* The cords of which they are respectively composed arise by anterior and posterior fasciculi. When they have arrived opposite to the foramina of the sacrum, through which they are to pass, a ganglion is formed, at which they unite, and then divide into *anterior* and *posterior* branches.† The uppermost of the anterior branches are large, and pass through the anterior foramina of the sacrum. The posterior are small, and go through the posterior foramina.

The *Posterior branches* are generally spent upon the muscles which lie on the sacrum and posterior parts of the pelvis, externally.

The anterior branches of the three first nerves send ramifications to the sympathetic. They unite to each other, and are joined by the last lumbar nerve, and by a branch of the fourth sacral, in the formation of the great sciatic nerve. This union constitutes the *Sciatic plexus.*

The anterior branch of the fourth nerve transmits branches to the sympathetic: it also sometimes sends a branch to the united nerves above, or the sciatic plexus. It sends branches to the hypogastric plexus, and to the contiguous muscles.

The fifth and sixth pairs, which are very small, terminate also in the contiguous muscles and in the integuments.

From the *Sciatic plexus,* or the nerves which compose it, several smaller branches go off. There are generally two which pass off backwards through the ischiatic notch, and are denominated *Gluteal,* as they are distributed to the glutei muscles. From the lowermost of these a branch descends on the thigh.

The *Pudic nerve,* which is appropriated to the organs of ge-

* The sixth pair, when they exist, proceed in a groove in the os coccygis.

† The ganglions of the fourth and fifth nerves are extremely small, and not so near the foramina as those of the others.

neration, also passes off from this plexus, and appears to consist of fibres which are derived from each of the nerves that compose it. It proceeds between the sacro-ischiatic ligaments and divides into two branches—an inferior and a superior. The *inferior* passes between the erector penis and the accelerator urinæ muscles, and is distributed to those muscles, to the bulb of the urethra and the interior of that canal, to the scrotum and dartos.

The *superior* proceeds along the os pubis to the symphysis, and passes between the bone and the body of the penis to the dorsum. A considerable branch accompanies the artery on the dorsum, and terminates by many ramifications, on the glans penis; after sending branches in its course to the integuments generally, and to the prepuce.

In females, the *Inferior pudic nerve* proceeds along the external labia pudendi to the mons veneris, sending off many ramifications in its course.

The *Superior pudic nerve* proceeds as in males, along the branch of the pubis to the superior surface of the clitoris, and terminates principally upon the extremity of that organ.

The sacral nerves unite in the sciatic plexus to form the great nerve of the lower extremity, which is next to be described.

The Great Sciatic Nerve

Proceeds from the pelvis through the ischiatic notch, between the pyramidalis, and the superior gemellus muscle; it then passes down to the back part of the thigh, between the tuberosity of the ischium and the great trochanter of the os femoris; and continues downwards, inclining from within outwards, to the ham, where it is situated between the tendons of the semi-tendinosus and semi-membranosus on the internal side, and the tendon of the biceps on the external. In this course it sends off branches to the muscles on the posterior part of the thigh.

As the great nerve passes down the thigh, it sends off obliquely downwards and outwards, a large branch which is called the *Fibular*, that passes across the head of the fibula to the external and anterior part of the leg. The place where this branch

separates from the main nerve is different in different subjects. It continues in contact with it for some distance, connected only by cellular membrane.

The Fibular or Peroneal Nerve

Proceeds downwards on the inside of the tendon of the biceps, and crosses obliquely to the outside of the external head of the gastrocnemius: it then passes inwards between the peroneus longus muscle and the fibula: and descending between the muscles on the front of the leg, divides into two branches, one of which inclines to the exterior side of the leg, and the other preserves an internal situation. In its course from the great sciatic nerve to the fibula, it sends off some superficial ramifications. The two branches into which it divides, after passing over the fibula, continue downwards. The *Internal*, after supplying the muscles on the anterior part of the leg, passes under the annular ligament like the anterior tibial artery; and on the upper part of the foot, divides into two ramifications, one of which proceeds forwards near the internal edge of the foot and the other near the external; they divide again, and are distributed to the parts on the upper surface of the foot, one of their ranula descending with the continuation of the anterior tibial artery to the sole of the foot.

The *External Branch* of the fibular nerve, as it proceeds downwards, supplies ramifications to the contiguous muscles, and passing through the fascia on the outside of the leg, continues between it and the skin towards the foot. In this course it generally divides into two branches, which are spent upon the upper surface of the foot.

The *Great Sciatic Nerve*, after the fibular nerve leaves it, continues down the thigh, between the tendons of the flexors, behind the great blood-vessels, and, of course, exterior to them.

In the ham, this great nerve takes the name of *Popliteal*, and proceeds across the articulation of the knee, between the heads of the gastrocnemii, to the posterior side of the tibia: here it passes through the upper portion of the soleus or gastrocnemius internus, and continues between it and the long flexor of the toes,

near the *Posterior Tibial Artery;* descending with that artery to the hollow of the os calcis. In this situation it has the name of

Posterior Tibial Nerve.

At the commencement of this course, a small distance below the internal condyle of the os femoris, it sends off a branch of considerable size, called the *Communicans Tibia,* or *Saphena Externa,* which passes down behind the gastrocnemii, and gradually inclines externally, so that it is situated on the external edge of the tendo Achillis, soon after the commencement of that tendon, and proceeds behind the external ankle, near the outer side of the foot, to the smaller toes: distributing branches to the contiguous parts. In its course on the back of the leg, it sends off a branch which unites with one of the superficial ramifications of the fibular nerve, and descends to the outer part of the foot.

The *Tibial Nerve,* in its course downwards, sends branches to the contiguous muscles, and a few twigs which form a species of network on the artery. In the hollow of the os calcis it sends off a superficial branch to the integuments of the sole of the foot, which proceeds on the outside of the aponeurosis plantaris: it there also divides into branches, which are denominated the *Internal* and *External Plantar Nerves.*

The *Internal Plantar Nerve* proceeds forwards, alongside of the tendon of the long flexor muscle of the great toe, giving off small branches in its course; about the middle of the foot it divides into four branches, one of which proceeds to the inside of the great toe; and a second to the angle formed by the great toe and the toe next to it, where it divides and sends a branch to the opposite sides of those toes: the other two branches are distributed in a similar manner, to the succeeding toes. These digital branches are connected with each other by small ramifications.

The *External Plantar Nerve* proceeds with the external plantar artery towards the external side of the foot, between the short flexor of the toes and the flexor accessorius. Near the external edge of the foot, about the posterior end of the metacarpal bones,

it divides into three branches. One proceeds to the outside of the little toe; another passes to the angle between the fourth toe and the little toe, and divides into branches which are distributed to the corresponding sides of these toes. The third branch proceeds more deeply in the foot, from the external towards the internal edge of it, and is spent upon the deep-seated contiguous muscles.

The Great Sympathetic or Intercostal Nerve

Commences in the cranium with those small ramifications of the pterygoid branch of the upper maxillary nerve, and of the sixth pair, which accompany the carotid artery through the canal in the petrous portion of the temporal bone. These small nerves form a network which surrounds the artery in the canal and gives rise to the incipient sympathetic, a small cord which passes down close to the nerves of the eighth and ninth pairs of the neck. Opposite to the second cervical vertebra, this nerve is swelled or dilated, so as to form a body of a light red colour, which is more than an inch in length, and has the form of two cones united to each other at their bases. This is the *Superior Cervical Ganglion* of the *Sympathetic Nerve*, and from it the nerve descends, behind the *Par Vagum*, on the front part of the neck.

This ganglion receives twigs from the first, second, third, and fourth pairs of cervical nerves, and also from the eighth and ninth nerves of the head. It sends off several twigs, which pass behind the carotid artery, at its bifurcation, and are joined by twigs of the *Portio Dura* and the *Glosso-Pharyngeal* nerves. From these united twigs proceed very small ramifications, which accompany several branches of the external carotid artery, and some of them pass down with the *Common Carotid.*

This superior ganglion also furnishes small twigs which accompany the *Glosso-Pharyngeal* to the tongue and pharynx. Sometimes a twig from it passes on the back part of the thyroid gland to commnnicate with the recurrent nerve. From this ganglion go off some small branches, which, uniting with others

from the superior laryngeal nerves, form the superior or superficial *cardiac* nerve, which will be soon described.

The trunk of the *Sympathetic Nerve* descends, on the front of the neck, from this ganglion, as has been already stated. In its course it receives very small twigs from the fourth and fifth cervical nerves, and sends some very small twigs which appear to go to the œsophagus, and some which unite to the laryngeal nerve and go to the thyroid gland. Some twigs which are larger proceed from it into the thorax, and go to the cardiac plexus hereafter to be described.

Opposite to the interval between the fifth and sixth cervical vertebræ it forms another ganglion, of an irregular shape, much smaller than the first. This ganglion, in different subjects, differs in size as well as in several other respects. Sometimes it is entirely wanting, and sometimes it is doubled. It is denominated the *Middle Cervical*, or *Thyroid Ganglion*. When the fourth, fifth, and sixth cervical nerves do not send ramifications to the sympathetic nerve, this ganglion receives twigs from them.

The *Middle Cervical*, or *Thyroid Ganglion* sends many ramifications downwards. Some of them enter the thorax and contribute to the formation of the *Cardiac Plexus;* others accompany the inferior thyroid artery, and, with twigs from the recurrent nerve, form a plexus which extends towards the thyroid gland. Some proceed downwards before, and others behind, the subclavian artery, to the next ganglion; among them is generally one which may be regarded as the trunk of the *Sympathetic*.

This third *Ganglion* is denominated the *Inferior Cervical*, or the *First Thoracic*. It is almost constantly found in the same situation, viz. between the transverse process of the last cervical vertebra and the head of the first rib, and is partly covered by the origin of the vertebral artery. It is generally larger than the middle ganglion. It receives branches from the sixth and seventh cervical, and the two first dorsal nerves. Ramifications pass from it to the par vagum and recurrent nerve, and also to the cardiac and pulmonary plexus.

From this ganglion the *Sympathetic Nerve* proceeds downwards on the side of the spine, as will be described hereafter.

The Nerves of the Heart,

Being derived from branches which have already been mentioned, are now to be described.

They arise principally from an arrangement of nerves denominated the *Cardiac Plexus*, or *Plexuses*, which is situated above the curve of the aorta, and extends, on the posterior side of it, from the root of the arteria innominata to the bifurcation of the pulmonary artery. This plexus is composed of nerves which are principally formed by the union of small ramifications that are derived from the three above mentioned ganglions of the *Sympathetic Nerve*, and the nerve itself; and also from the *Par Vagum*, and some of its branches.

These nerves are denominated the *Cardiac*. They descend on their respective sides of the neck, but are somewhat different on the different sides. On the *right* side three nerves have been described as particularly entitled to this name, and on the *left* side but two.

The first on the *right* side is denominated *Superior*, or *Superficial Cardiac Nerve*. It generally arises by several fine threads, which unite into one delicate cord that passes down by the side of the common carotid. When it has arrived on a line with the middle ganglion, it sends a twig to the thyroid plexus, and another that communicates with a twig from the par vagum, which continues downwards on the carotid artery. After passing beyond the ganglion, it divides into several branches, which unite themselves to branches of the recurrent nerve that are going to the middle ganglion.

The second, which is denominated the *Middle Cardiac*, the *Great Cardiac*, or the *Deep Cardiac*, is the largest of the three. It arises from the *Middle Cervical*, or *Thyroid Ganglion*, by five or six fine fibrils, which finally form one, that passes before and across the subclavian; and at that place, as well as lower down, it receives twigs from the par vagum: below this, it is joined by

a considerable twig from the recurrent, and terminates in the *Cardiac Plexus,* to which it contributes largely.

The third cardiac nerve of the right side is called the *Inferior,* or the *Small Cardiac Nerve.* It originates from the third, or lower cervical ganglion, by many fibrils which unite into a smaller number that form a plexus. It crosses behind the subclavian, and proceeds on the outside of the arteria innominata to the curve of the aorta; continuing between it and the pulmonary artery, to the anterior coronary plexus. In this course it receives several fibres from the recurrent and the par vagum.

On the left side the first cardiac nerve arises from the upper ganglion. The second derives its origin from the two lower ganglions.

The left superior or superficial cardiac nerve arises like the right, by many distinct fibres, and proceeds downwards in the same way. It descends between the carotid and the subclavian, and when it has arrived at the place where they originate from the aorta, it divides into a great number of small ramifications. Some pass before the aorta, either to join the branches of the inferior cardiac, or to unite with the cardiac branches of the left nerve of the par vagum. The others proceed behind the aorta, and enter into the common cardiac plexus.

The second cardiac nerve of the left side may be called the *Great Left Cardiac,* and has a double origin, as above mentioned. The principal branch in its composition arises from the lowest cervical ganglion, and passes behind the transverse portion of the subclavian artery. Where the inferior thyroid artery arises from the subclavian, this branch receives a considerable number of ramifications, which arise from the upper ganglion, and are interwoven with each other before they unite to it. It passes behind the curve of the aorta, and terminates in the great cardiac plexus, which it particularly contributes to form. Here it is joined by many fibres from the par vagum.

The Cardiac Plexus

Is situated principally behind the curve of the aorta, at a

small distance above the heart. It commences as high as the origin of the arteria innominata, and extends downwards to the bifurcation of the pulmonary artery.

As has been already mentioned, it is principally composed of branches from the middle cardiac nerve of the right side, and the inferior cardiac nerve of the left; but it receives branches from the superior cardiac of the left, and sometimes of the right side. Some fibres of the inferior cardiac of the right are also united to it.

Many branches proceed from this plexus.

A small number pass upon the aorta, and seem to enter into its texture.*

Some of them also combine with the ramifications of the *Par Vagum* in the anterior pulmonary plexus.

The majority proceed to the basis of the heart, near the origin of the pulmonary artery and the aorta, and constitute the *proper nerves of that organ*. They accompany the coronary arteries, and are so arranged around them that, by some anatomists, they have been said to form plexuses, which have been denominated *Coronary*.

The *Sympathetic Nerve*, as has been stated above, proceeds from the ganglion, called the *Lower Cervical*, or the *First Thoracic*, before the neck of the first rib. It continues to descend, in the same direction, along the spine, exterior to the pleura, to the inferior part of the thorax. Near the head of each rib it forms a ganglion, which unites with the intercostal nerve behind it, by two branches, and thus forms an indirect communication with the medulla spinalis.

From several of the uppermost of these ganglions small twigs proceed to the pulmonary plexus, and also to the great trunk of the aorta, below the curve forming a species of network, or plexus upon it.

From the ganglions near the heads of the fifth and sixth ribs, and from four or five of the ganglions which succeed them, small nerves arise, which proceed downwards on the sides of

* It has been asserted that some of the anatomists of Paris have traced these nerves on the aorta, to a great distance from the heart.

the bodies of the vertebræ, and unite into one trunk that is denominated the *Splanchnic Nerve*, because it is distributed to the viscera of the abdomen.—This nerve proceeds behind the crus of the diaphragm, on its respective side, into the abdomen. A second and smaller nerve, of the same destination, called the lesser *Splanchnic Nerve*, arises lower down, from two or three of the lowermost dorsal ganglions, and penetrates separately into the cavity of the abdomen: it then generally divides into two branches, one of which unites to the great splanchnic nerve, and the other proceeds to the *renal plexus* soon to be described.

As soon as the great splanchnic nerve has entered the abdomen, it divides into many branches, which commonly form small ganglions on each side of the cœliac artery, but above it. These ganglions are generally contiguous: but sometimes they are at a small distance from each other, and united by nerves. They are, however, commonly spoken of as one, and called the *Semilunar Ganglion*. They are of irregular forms, and very different from each other in size, as well as form. Those formed by the splanchnic nerve on one side are sometimes different from those on the other.

From this assemblage of ganglions proceed many small nerves, which are woven together so as to form a network denominated the *Solar Plexus*.

This plexus is situated anterior to the spine and the crura of the diaphragm, behind the stomach and above the pancreas; and is extended upon the cœliac and superior mesenteric arteries. Some ramifications from the par vagum and the phrenic also join it.

The lower part of the solar plexus, which surrounds more immediately the cœliac artery, is termed the *Cœliac Plexus*. From it networks of nerves extend upon the great branches of the artery to the organs to which they go.

They extend to the stomach, (although it is supplied by the par vagum,) along the superior coronary or gastric branch of the cœliac; and the fibres in their composition being spread upon the coats of the stomach, unite with the branches of the par vagum, which are also spread upon them.

A similar network, denominated the *Hepatic Plexus*, extends upon the *Hepatic Artery*, and from it to the *Vena Portarum*; and accompanies those vessels into the substance of the liver. It also sends branches to the biliary duct and gall-bladder; to the stomach by the arteria gastrica dextra; and to the omentum.

The *Splenic Artery* is invested by a similar but smaller arrangement of nerves, denominated the *Splenic Plexus*. In its course to the spleen, this plexus sends some nerves to the pancreas; and also to the stomach and omentum, with the left gastric artery.

The superior mesenteric artery is surrounded by a network, which extends to it directly from the solar plexus, and is the largest of all which proceed from that plexus. The *Mesenteric Plexus* at first nearly surrounds the artery, and proceeds with it between the lamina of the mesentery. In this course it sends branches, with the arteria colica dextra, to the transverse portion of the colon. Between the lamina of the mesentery, it sends ramifications with all the branches of the artery, to the small intestines generally; to the cœcum, and the right portion of the colon, as well as to the mesenteric glands.

From the lower part of the solar plexus a network proceeds, on the front of the aorta, to the inferior mesenteric artery, and surrounds it. Nerves from this plexus accompany the artery to the left portion of the colon and the rectum. Some of their ramifications combine with those of the hypogastric plexus.

The *Emulgent Artery* is attended by nerves, which are arranged like a network on its anterior and posterior surfaces, and are denominated the *Renal Plexus*. They are derived from the solar plexus, and frequently contain small ganglions. They proceed with the artery to the fissure of the kidney, and are distributed with its different ramifications, in the substance of the organ.

Some branches pass from them to the renal gland with the capsular artery.

Before the renal plexus arrives at the kidney, it sends off, from its inferior part, some new fibres, which, after joining some others from one of the lumbar nerves, accompany the spermatic

arteries, and are, therefore, called the *Spermatic Plexus.* In the male these fibres proceed through the abdominal ring, and many of them go to the testis, but they are followed with great difficulty, on account of their small size.

In the female, they go to the ovary and the Fallopian tubes.

From the great plexuses above, a small network continues downwards on the aorta, receiving fibres from the intercostals on each side; at the great bifurcation of the aorta it divides, and is joined on each side by many ramifications from the third lumbar nerves, which thus form a plexus of considerable extent, that sends nerves to the bladder, rectum, and vesiculæ seminales in males; and to the uterus and vagina, as well as the bladder and rectum, in females.* This is called the *Hypogastric Plexus.*

The plexuses above mentioned are derived from the splanchnic nerve, which come off from the *Sympathetic* in the thorax.

The *Sympathetic Nerve,* after giving off the lesser splanchnic, is diminished in size, and approaches nearer to the bodies of the vertebræ. It passes through the crura of the diaphragm, and then proceeds forwards and downwards upon the spine, between the tendinous crura of the diaphragm and psoas muscle; near the vena cava on the right side, and the aorta on the left. In this course, it generally receives one or two small cords from the anterior branch of each of the lumbar nerves; these cords proceed downwards and forwards, between the bodies of the vertebræ and the psoas muscle, and a ganglion is generally formed at the place where they join the nerve.

In its descent on the lumbar vertebræ, the sympathetic sends off several nerves that unite to the network which descends on the aorta from the plexus above. After passing over the lumbar vertebræ, it descends into the pelvis, close to the sacrum, on the inner side of the great foramina: here it also forms ganglions, and communicates with the sacral nerves, and likewise with the hypogastric plexus. It terminates on the os coccygis, where its minute fibres join those of the opposite side.

* Although the testicle receives nerves which are derived from the sympathetic, the penis and other external parts of the organs of generation do not: the nerves which accompany the pudic artery being derived from those which unite to form the great sciatic.

Fig. 1

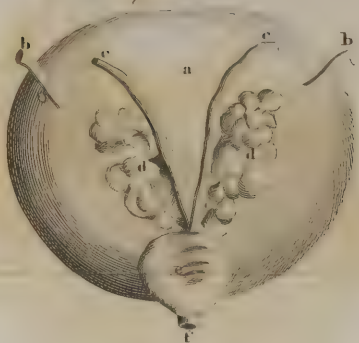


Fig. 4

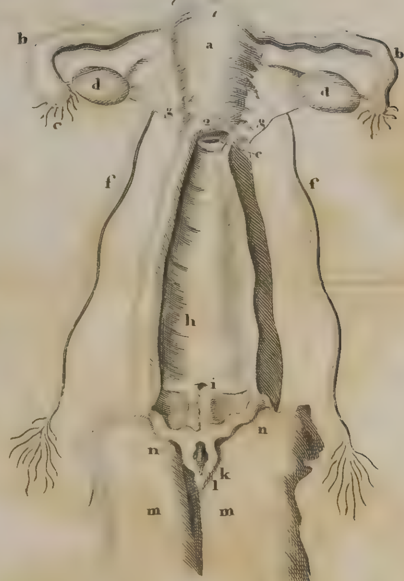


Fig. 2

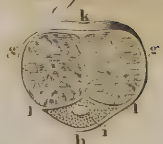


Fig. 5

Fig. 6

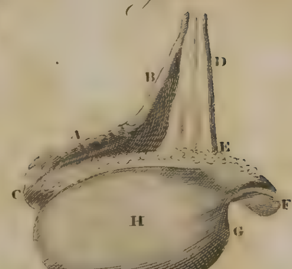


Fig. 3

EXPLANATION OF PLATE X.

Fig. 1. Represents the under and posterior side of the Bladder of Urine, &c.

a, The bladder. b b, The insertion of the uterus. c c, The vasa deferentia, which convey the semen from the testicles to d d, the vesiculæ seminales,—and pass through e, the prostate gland, to discharge themselves into f, the beginning of the urethra.

Fig. 2. A transverse Section of the Penis.

g g, Corpora cavernosa penis. h, Corpus cavernosum urethræ. i, Urethræ. k, Septum penis. l l, The septum between the corpus cavernosum urethræ and that of the penis.

Fig. 3. A longitudinal Section of the Penis.

m m, The corpora cavernosa penis, divided by o, the septum penis. n, The corpus cavernosum glandis, which is the continuation of that of the urethra.

Fig. 4. Represents the Female Organs of Generation.

a, That side of the uterus, which is next to the os sacrum. 1, Its fundus. 2, Its cervix. b b, The Fallopian or uterine tubes, which open into the cavity of the uterus;—but the other end is open within the pelvis, and surrounded by c c, the fimbriæ. d d, The ovaria. e, The os internum uteri, or mouth of the womb. f f, The ligamentum rotundum, which passes without the belly, and is fixed to the labia pudendi. g g, The cut edges of the ligamenta lata, which connect the uterus to the pelvis. h, The inside of the vagina. i, The orifice of the urethra. k. The clitoris surrounded by l, The præputium. m m, The labia pudendi. n n, The nymphæ.

Fig. 5. Shows the Spermatic Ducts of the Testicle filled with Mercury.

A, The vas deferens. B, Its beginning, which forms the posterior part of the epididymis. C, The middle of the epididymis, composed of the serpentine ducts. D, The head or anterior part of the epididymis unravelled. e e e e, The whole ducts which compose the head of the epididymis unravelled. f, f, The vasa deferentia. g g, Rete testis. h h, Some rectilinear ducts which send off the vasa deferentia. i i, The substance of the testicle.

Fig. 6. The Right Testicle entire, and the Epididymis filled with Mercury.

A, The beginning of the vas deferens. B, The vas deferens ascending towards the abdomen. C. The posterior part of the epididymis, named *globus minor*. D, The spermatic vessels enclosed in cellular substance. E, The body of the epididymis. F, Its head, named *globus major*. G, Its beginning from the testicle. H, The body of the testicle, enclosed in the tunica albuginea.

CHAPTER XVI.

GENERAL ANATOMY OF THE NERVOUS SYSTEM.

—In man, and in animals the nearest to man in the scale of organization, the nervous system, by its bulk and general distribution, no less than by the important functions it executes, forms a very prominent part in the constitution of the body. So early as the time of Herophilus, who flourished nearly three centuries before the commencement of the Christian era, the connexion of the nerves with the brain had been discovered; and they had been regarded as the instruments of sensation and motion; and, in the sixth century, Galen entertained the idea that there was some specific difference among the nerves. He held that the nerves of sensation originated in the brain, and those of motion, in the spinal cord. Closely connected, as it was found to be, with the phenomena of life, the nervous system has been, since the commencement of the seventeenth century, a subject of much research among anatomists; but, from its being the most delicate and complicated in its structure, of all the tissues of the body, it has necessarily required extremely careful and oft repeated examination, and the progress made in its investigation, has consequently been slow.

—Comparative anatomy has lent its aid to the elucidation of nervous structure; one after another, in the downward grade of animals, has been shown to possess nervous centres and nervous cords, and the recent observations of Tiedemann, Ehrenberg, Remak, etc., have rendered it extremely doubtful that any animal exists without a nervous system, properly proportioned to the force and vitality of its vital actions.

—The nervous structure of man, and many of the inferior animals, is found disposed in masses, as in the brain and spinal marrow; rolled up in the form of round cords, called nerves, which branch in every direction through the body; and as small knots,

or ganglia, which are developed in the course, or at the origin of the nerves. Though thus diversified in its mode of disposition about the body, the nervous substance, or *neurine*, as it is now more appropriately called, is susceptible of being divided from its physical qualities and difference of functions, into two kinds, the *cineritious* and *medullary*.

—The cineritious neurine, *substantia cinerea*, as the term imports, has derived its name from its gray or ash colour, and is soft and pulpy. It is found only in the brain and spinal marrow, and in the ganglia of the nerves.* It forms the central part of the medulla spinalis, and has received, at that part, the name of the *nucleus* of the spinal marrow. It is found also, in the central parts of the cerebrum, the cerebellum, the crura cerebri, the pons varolii and the medulla oblongata. It forms, besides, the whole of the *outer* covering of the cerebrum and cerebellum, existing there in the form of a layer, a line to a line and a half in thickness, dipping down between and covering the bases and sides of the convolutions of the cerebrum, as well as the horizontal layers of the cerebellum, and thus amplifying the superficies of those organs to three or four times that of the interior surface of the walls of the cranium. From the external position it occupies in these organs, it has been called, though very inappropriately, the cortical substance of the brain. It is very abundantly supplied with blood-vessels, which exist in it in the form of meshes of capillary vessels, conveying red blood, and pervade its whole substance, so as to render it one of the most, if not the *most vascular portions* of the body, and to be the cause of the grayish brown colour from which the name of *cineritious* has been derived. It is of a darker colour in man than any other animal, and is found gradually to become paler, as we descend in our investigations, down the animal scale. Some of the central deposits of cineritious matter in the interior of the

* The microscopical observations of Remak and Müller, have shown it to exist occasionally in the nerves of the sympathetic, and in some of the encephalic nerves of the cerebro-spinal system. But in such cases, the nerves containing it are devoted wholly to the organic functions, and may be considered rather as elongated funicular ganglia.

brain, are of a deeper colour than that covering the surface: thus, that in the crura cerebri has received from Sömmering* the name of *locus niger*, that of the corpus dentatum is yellowish, and which is said by Tiedemann to be entirely owing to their greater vascularity.

—When examined by the microscope, the cineritious substance is found existing in the form of molecules or minute globules, embraced in the meshes of the capillary vessels, having no very distinct linear arrangement, but forming a granular mass, or layer spread over and amidst the medullary matter.

—A striking peculiarity in the mode of disposition, of the cineritious matter, is its distribution generally in detached portions. Thus, the cineritious coatings of the cerebrum and cerebellum, have no direct continuity with each other; nor have the cineritious deposits in the interior of these organs, any communication except through the medium of the white or medullary portion of the brain, with that of the spinal marrow, or of the different ganglia upon the trunks of the nerves.

—The cineritious matter, when examined with the microscope, either in the brain, spinal marrow, or ganglia, is found composed of globules or granules of considerable size, having no distinct linear arrangement, but embraced in meshes of capillary vessels and cellular tissue, which serve to isolate them from one another. Each of these globules, according to Valentine, contains two nuclei, one concentric and within the other, but which I have not myself, even with the aid of a very powerful microscope been able to detect. It has long been suspected that the globules of cineritious substance, were in some way connected with the termination, or origin of the nervous fibrils, and thus serving as Gall has suggested, as the matrix or generator of the white fibres. The question may now be considered as nearly decided; for Remak and Müller,† both assert, that in their microscopical investigations they have seen tooth-like white fibres coming off from the

* This variety of colour in different portions of the cineritious substance, is not peculiar to man. Cuvier found it to be the case in regard to the ganglia of some of the lower animals. In the Helices he found the ganglia red, and in the Aplysia, black, while the nerves were white.

† Müller's Physiology, part 3, vol. i., Bennet's Translation.

surface of the cineritious globules. Remak succeeded in the ganglion, in isolating these tooth-like processes to an extent of many times their diameter, so as to be enabled to observe their similarity to the primitive gray fibres of the *ganglionic* nerves. There is therefore some reason to believe that this is the mode of origin of many of the ganglionic nerves, that is, those which exclusively belong to the organic functions, and that many of the cerebro-spinal originate in the same way, especially those which have latterly been denominated the excito-motory, or with more propriety, the reflex system of nerves.

—The medullary neurine, *substantia medullaris*, forms a large portion of the interior of the cerebrum and cerebellum, and from its central position, like that of the medulla or marrow within the cavity of a bone, it has received the name of medullary. But this term is far from being generally appropriate, for the *medullary* nervous substance, is found forming the exterior of the crura cerebri and cerebelli, the pons varolii, medulla oblongata and spinal marrow, and very nearly the entire structure of the nervous cords. But the term, introduced at an early period, has become so hallowed by usage, as to be considered now almost classical in anatomy. The medullary nervous substance is every where in its natural state of a white or cream colour. Unlike the cineritious substance of the brain, the medullary is *apparently* placed no where in detached masses; the nervous cords are continuous with the medullary portion of the spinal marrow, and this again with the medullary masses of the encephalon. The ganglia themselves being no interruption to the course of the nervous cords.

—Unlike the cineritious matter also the medullary is every where found to be fibrous; a fact which was first demonstrated by Vieussens in 1684,* and which is now as generally admitted as any other truth in anatomy and physiology, and may be shown convincingly on a hardened brain to the most sceptical inquirer.

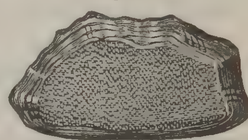
—The mode adopted by Vieussens in order to display these medullary fibres, was that of scraping its surface in the recent

* Vieussens, Neurographia Universalis.

state; the same adopted by Gall, Spurzheim, Reil, and others, in the present century, by whom the *anatomy* of the brain, though still very imperfect, has been greatly advanced.

—In the medullary neurine, when examined with the microscope, no globules of considerable size and detached distribution, like those of the gray matter, are ever met with; but the white matter, whether examined in the brain, spinal marrow, or white nerves, presents, when separated into its ultimate elements, the appearance of parallel white fibres, the diameter of which, according to R. Wagner, is, in man, the $\frac{1}{277}$th part of a line, and to Raspail, the .0087th part of an inch.

*Fig. 92.**



—These primitive fibres are simple threads, formed of a cylindrical sheath, filled with the nervous matter, and each one of these fibres, according to the elaborate investigations of Ehrenberg and Müller, however frequently they may cross each other, or appear to unite, when they are rolled up in bundles as in the nerves, or penetrate through the ganglia, or through the substance of the brain, *never unite* or do more than come in close opposition with one another; still being separated by their neurilematic sheaths, which insulates them as completely from one another as the windings of a silk thread, insulate the coils of wires, which serve as the conductors of a galvanic battery. When the bundles of white fibres constituting two or more nerves come together, and appear to anastomose directly, or form a plexus, there is only a separation and recombination of the primitive filaments in a different order, so as to render more intimate the connexion existing between different organs of the body. In this manner the nervous substance of each fibril, is maintained separate in its course, so as to have no communication, except with the part from which it arises, and that to which it is distributed; and however flexuous or involved its direction may be, or with whatever different orders of nerves it may be

* Fig. 92, is a microscopical view, after Raspail, of a transverse section of a branch of a ganglionic nerve, which appears as a single cord. The cut ends of the filaments are here seen.

incidentally wound up, its functions are, nevertheless, as directly and singly exercised, as though there existed but one order of fibres in the body. The neurilematic covering investing the primitive fibres, is very delicate, almost gelatinous in the brain, so as to render the tracing of the fibres through that organ, a matter of extreme difficulty.

—But the existence of the neurilema there is nevertheless evident, and especially as I have several times had occasion to observe, in cases of atrophy of parts of the brain, where the nervous substance had been removed, and the neurilema left, forming a shrunken mould of the part.

Fig. 93.*

—In the sympathetic nervous system, there is, agreeably to Remak, a mixture of white and gray fibres, constituting the trunks of the nerves. The gray fibres, originate from the sympathetic ganglia, and are smaller in diameter than the corresponding white fibres, and have their surface here and there beset with minute granules of gray matter. The white fibres which are seen in the sympathetic nerves intermixed with the gray, especially in the neck, the loins, and the splanchnic nerves, the same observer believes to be additional sensitive, and perhaps excito-motor nerves extending into them from the cerebro-spinal system.

—Some of the cerebro-spinal nerves, as the trigeminus and glosso-pharyngeal, contain some gray fibres of a similar sort, according to Remak, which are derived from the sympathetic, and intermixed with those coming from the brain.

* Fig. 93, a similar transverse section of a median nerve, which exhibits several cords, every cord or fasciculus having its own membrane, and all included in an envelope or neurilema common to the whole. The cut ends of the fibrils forming each fasciculus are seen. The single dark spot represents a blood-vessel.

—Mr. Johns* is the only chemist who, in his analysis of the brain, has hitherto separately examined the gray and white matter. He has stated that the white matter contains more fat than the gray, and that its albumen is more firm. The following comparative analysis was made of the brain of one of the insane patients who died at the Salpetrière.

Entire Brain, (*Density* 1048.)

Water,	77.0
Albumen,	9.6
White fatty matter,	7.2
Red fatty matter,	3.1
Osmazome, lactic acid, salts,	2.0
Earthy phosphate,	1.1

(*Comp. Analysis.*)

	White Subst.	Gray Subst.
Water,	73.0	85.0
Albumen,	9.9	7.5
White fatty matter,	13.9	1.0
Red fatty matter,	0.9	3.7
Osmazome, etc.,	1.0	1.4
Earthy phosphate,	0.3	1.2

Functional Divisions of the Nervous Substance.

—The student who wishes to form for himself a comprehensive and philosophical knowledge of the structure and functions of nervous matter, will do well to examine it in its simplest state of developement as it is found in the radiated or star-shaped animals, in which unequivocal voluntary locomotive power exists, and where it is found dissected and simplified as it were by the hand of nature. In these animals we find a ring of nervous ganglia, connected by intermediate cords or commissures which unite them together, surrounding the mouth and œsophagus; and from the little nodules or ganglia which are placed opposite the

* Journal de Chimie Med. 1835; Solly on the Brain, p. 8. London, 1836.

rays or limbs of the animal, part nervous cords, which are distributed to the muscles, and are unquestionably the instruments of locomotion. Proceeding in his investigations up through the articulated, molluscous, and vertebrated animals to man, he will find the nervous system expanded in form, and complicated in arrangement, so as to harmonise exactly with the developement of the different classes of animals, and the elevation of their vital functions. Life, which appeared at the zero point of the scale, to be manifested chiefly by motions excited by the contact of bodies, (mere excito-motory phenomena,) becomes complicated, as we ascend, with the action of other organs, larger ganglia being placed at the region of the head, which give the instinctive impulses to animals. Finally, as we approach the elevation of man, we find a cerebral ganglion, assuming more and more the appearance of a brain, and endowed with instinctive faculties, which approach slightly in character to the moral and intellectual, till in man himself we find this part expanded forward and upward so as to constitute a preponderating mass of nervous substance, called encephalon or brain, which retains all the instinctive properties found in similar organs of the animals below him, and is endowed in addition with the high and governing qualities of the mind; some of the organs, as those in the interior of his body, still living and acting by a system of excito-motory or organic phenomena, like those of the radiata, and for which we find arranged a separate system of ganglia and nerves.

—In tracing up the anatomy of the nervous system in this manner, it will be found consisting entirely of the cineritious and medullary neurine, variously disposed throughout the body, so that the whole nervous structure, can be classed according to its functions into three parts which may be called the factors of nervous influence. 1st. Ganglia composed principally of cineritious neurine, and which are believed to be the only sources of power in the nervous system. 2d. Commissures or bands which connect and associate the different ganglia with each other, composed sometimes of the cineritious, but most generally of the medullary neurine. And 3dly, Nerves or cords, formed almost

exclusively of the medullary neurine, which establish communications between the ganglia, and all the different portions of the body. The nerves are but the passive agents of the ganglia, and have but a single and common function, and the commissures, so far as their offices have yet been made out, have no more; but the ganglia, differing among themselves greatly in size and form, seem each on either half of the body to be endowed with its peculiar function. Solly,* a late and a judicious writer on this subject, has fully carried out this idea in his treatise on the brain.

—Adopting at the outset, this rational and philosophical view of the nervous system, the student will have a physiological guide before him, which will, more satisfactorily than any other, lead him through this interesting and important portion of anatomy, that is yet far from being perfectly understood, and is obscured by a multitude of different terms applied, often coarsely, to different parts of the same physiological organ, from their resemblance to some other objects, or from mistaken views in regard to their functions. The perpetuation of these senseless terms, applied, many of them, at an early period of the science, and the conflicting accounts of the structure and functions of the different parts of the brain, has given to the description of the nervous system a labyrinthine appearance, in which even a zealous student, finds himself entangled, and is apt to rise from its study despairingly, his memory loaded with names, and his mind charged with very indefinite notions of its structure and functions. Neurology within the last half century, has made such rapid advances, that anatomists have become emboldened, to study the parts of the nervous system in their natural order, without reference to the artificial system, so long practised in regard to the brain, of studying it in horizontal slices; which can no more teach the structure of its different parts, than would a series of transverse sections of the thigh, teach us the origin, course, and uses of its different muscles. Following out these views of late investigators of the nervous system, we shall see

* Op. citat.

many difficulties to disappear from the tangled subject, and the whole present itself in a light much more lucid and tangible to the mind.

Of the Ganglia.

—The term of ganglion which was originally applied to a knot or rounded mass of isolated cineritious neurine developed in the course of the white fibres of a nerve, may well be applied, since the term has come into such common use, to any isolated mass of cineritious substance, whatever its form; whether spread out in a thin layer, folded upon itself, as in the outer part of the cerebrum and cerebellum, or forming a long cylindrical mass surrounded by the white matter, as in the spinal marrow; since the generally rounded ganglia of the nerves, present themselves under all varieties of forms, and thus prove that shape exercises no specific influence in regard to function.

—Hence, the outer layers of the hemispheres of the brain, are now spoken of as the hemispherical ganglia,* in which is manifested the intellectual and moral faculties; the cineritious nucleus of the spinal marrow, as a series of spinal ganglia, (which will be found in the lower animals to consist of separate knots,) whose office in particular it is, to preside over the sensations and voluntary motions of the limbs and body; and the ganglia of the sympathetic nerve, as bodies which exercise nearly the same office as the spinal cord in regard to the involuntary parts of the body.

Of the Medullary Neurine forming the Commissures.

—White bands of medullary neurine are found in many portions of the cerebro-spinal system, passing from side to side between symmetrical ganglia, arising from one, so far as we can carry our investigation, and terminating in the other, which are called commissures, and whose office it appears to be, to attach together these different organs so as to give to them a certain sort of unity in their operations.

—We have one instance of the many commissures that exist in

* Solly, oper. citat.

the corpus callosum, which is extended across between the two hemispheres of the cerebrum, at the only place where they can come in contact, immediately below the falx major; and another in the white fasciculi that pass across from the cerebellum over the pons varolii, (see Fig. 99, page 523,) and meet with those of the opposite side on the middle line of the pons. These constitute the great commissures or bonds of union of the two sides of the cerebrum and cerebellum.

—In the ganglia of the sympathetic, parts of the fibres of the evident white cords connecting the ganglia together, are believed, by Solly, to belong to the system of commissures.

Of the Nerves.

—The means by which the ganglia are placed in connexion with the organs of sense, the skin, muscles, and other portions of the body, are the thousands of white medullary filaments, which, shortly after their origin, from the central parts of the nervous system, pass out among the other tissues of the body, where they are rolled up into cylindrical cords and receive the name of nerves. These, for the purposes of greater clearness in description, are represented as dependencies of the central ganglia and running from them to the different parts of the body. But they are, in fact, merely agents of communication, between the various ganglia of the nervous system, and the different organs of sense and motion. Some fibres carrying impressions from without inwards to the ganglia; others in the opposite direction, transporting the motive or other influences which these impressions have excited in the ganglia, (especially those of the cerebrum,) outwards to the muscles.

—It has been already observed, (page 494,) that the medullary substance, consists, when closely analysed, of minute elementary filaments, each one surrounded by a separate neurilema, or cylindrical sheath, which isolates it in its passage through the different parts from its origin to its termination, and at the same time serves to support it in connexion with the coats of surrounding filaments, a number of which go to constitute a nervous cord. In the brain and spinal marrow this same filamentous arrange-

ment exists, though more difficult of observation there, in consequence of the nerves, as they are extended upwards into the brain, being no longer rolled up in cords, but the whole expanded in juxtaposition with each other, each filament being separated by a very delicate cellular sheath. These primitive filaments are so extremely minute, their pulp is so soft and yielding, and their sheaths so delicate, that it is difficult to trace them, but the fact that a portion of the white fibres of the brain are continuous with those of the nerves, will no longer admit of being called in question. We say a part of the white fibres of the brain, for there is some reason to believe, according to the doctrines of Gall, that some white fibres, arise *de novo*, in the gangliform masses of cineritious matter placed at the base of the brain, and go to increase its bulk. On the other hand, recent researches have shown that a *part only of the fibres of the nerves*, are continuous with the brain, some terminating and originating in the ganglia as organic filaments, and others terminating and originating in the cineritious substance of the spinal marrow and the base of the brain, to which the term of *excito-motory* has been applied, the anatomical basis of which doctrine we shall next investigate. The study of the functions of the nervous system, are rendered more clear and comprehensible by this view, which is something in proof of its anatomical correctness. The researches of Flourens* have shown, conclusively, that the seat of ordinary sensation and voluntary motion, is exclusively in the brain, and that there are many parts of the body gifted with peculiar instinctive sensations and involuntary movements, and which are capable of exercising their offices to a greater or less extent, even when separated from the brain. Such are the parts which receive their supply from the ganglia of the sympathetic, and those which obtain it by trunks arising from the spinal marrow and medulla oblongata. The dissections and experiment of Sir C. Bell, before whose time the spinal marrow was considered a sort of tail-like appendage to the brain, as well as those of Magendie, have established as unquestioned facts, that the anterior and posterior roots of the spinal nerves, and the anterior and posterior

* Recherches Experimentales, sur le Propr. et les Fonct. du Syst. Nerveux, etc.

columns of the spinal marrow, from which these roots come out, are destined,—the former or anterior, for motion, and the latter or posterior, for sensation. Many of the other assertions of Sir C. Bell, have not stood the test of closer examination, and according to Mr. Grainger, he has changed his own views in regard to them. Thus, beside the anterior and posterior columns of each half of the spinal marrow he admits a middle or lateral portion, between the two former, which other anatomists have not been able to discover. He supposed all the white fibres of the cord continuous with those of the brain on the one hand, and with those of the nerves on the other; the most superficial of the fibres of the cord passing off, as the cervical nerves, and so the whole given off in succession, till the most internal leaves it below, as the sacral and coccygeal; thus making the spinal marrow merely a large nervous cord, in which the cineritious matter placed in its interior, appears no more to be needed than in any other nervous trunk. At the upper part, however, of the spinal marrow, where his imaginary lateral column is placed, he believed the nerves destined to respiration arose, and that these were capable of exercising their functions occasionally, as in sleep, apoplexy, etc., through the influence of this column alone, without, and even in opposition to the agency of the will.

—He has thus, though obscure and mistaken in many of his views, established an interesting fact, that the function of respiration, even in man, is partly an instinctive act, and opened a new and important path of investigation. Anatomists following in his train of observation, have shown the cineritious nucleus of the spinal marrow, to be the source and origin of many of the fibres of the spinal and cerebral nerves, as he supposed the lateral column of the medulla oblongata to be to the respiratory. Meckel and Cruvielhier assert that this appears to be the case to them; Ollivier and Gall, have asserted it more boldly; and Mayo and Marshall Hall,* seem to have p oved it by their experiments, in which they separated the cord from the brain at various heights, and found that nerves which come off from below the place of separation, running to the eye, nose, anus, &c., were still

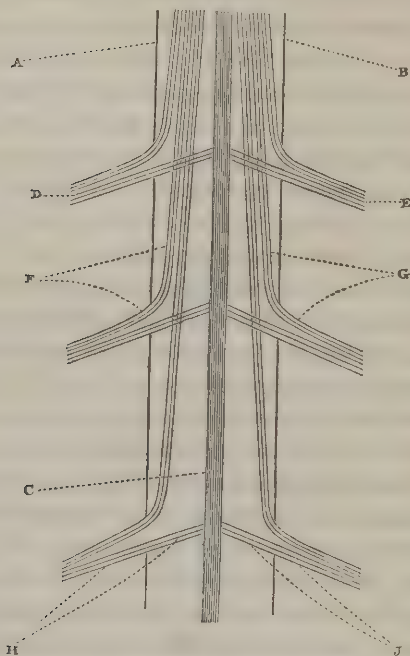
* *Vide* Mayo's Physiology, and M. Hall on the Nervous System.

found, on mechanical irritation, to possess a sort of instinctive sensation, and to be capable of producing combined involuntary muscular movements to a certain extent; and more recently Mr. Grainger* of London, (see Fig. 97, page 512,) by adopting an improved method of investigating the origin of the nerves, has succeeded in tracing a part of the fibres of the anterior and posterior roots of all the spinal nerves, into the cineritious matter of the spinal matter, where they end, another portion of the fibres of the same nerves, turning upwards, and constituting a part of the spinal cord in its course to the brain. This course of the nerves, Mr. Grainger observes, he has demonstrated to the entire satisfaction of Professors Arnold, Burdach, and Sir C. Bell. The same thing has also been nearly conclusively shown to exist in regard to the encephalic nerves, the principal difference between which and the spinal nerves, is their origin from a different portion of cineritious matter, and their not so usually having their fibres of sensation and their fibres of motion rolled up into a common fasciculus, as is the case with the spinal nerves, but running out to their destination mainly as distinct nerves, those of sensation and those of motion. Those fibres of the anterior and posterior roots of the spinal nerves, that terminate in the spinal marrow, are called by Hall and Grainger, the *true spinal, excito-motory* or *incident* and *reflex spinal nerves*, and considered to derive their origin and power from the cineritious matter of the spine in which they arise, and their functions to be as much involuntary and organic, as any of those which belong to the sympathetic nervous system. Those which pass upwards into the brain are called the *cerebral sensiferous and motorial nerves.*†

* On the Structure and Functions of the Spinal Cord. London, 1838.

† By a typographical oversight, in a footnote, vol. i. p. 256, the term *excito-motory* appears to be applied to the muscles: a reference to the text above will exhibit its true meaning. The phenomena, characterised as excito-motory, were known to Whytt, and are not peculiar to the parts which receive their supply of nerves from the spine; every portion of the nervous centres which gives origin to nerves, being endowed with peculiar functions, and to which the nerves serve as conductors.

Fig. 94.



—Fig. 94, is a plan of the spinal cord from Grainger, intended to show the arrangement of the gray and fibrous substances represented in profile, and the course of the true spinal or excito-motory nerves, and the true cerebral sensiferous and motorial nerves; *a*, anterior surface of the cord, *b*, posterior surface. The respiratory nerves of Sir C. Bell, will no longer then stand apart as a separate system, but will come under the same category with the *excito-motory*, to which the great sympathetic, as has been already shown, in a measure belongs.

CHAPTER XVII.

OF THE SPECIAL ANATOMY OF THE SPINAL MARROW AND BRAIN, AS DESCRIBED FROM BELOW UPWARDS.

—HAVING investigated the general anatomy of the nervous system, according to the most recent and improved methods, the student may enter with advantage upon the study of its particular parts; and for the convenience of demonstration, it will be best to retain the artificial divisions, commonly made, viz; 1st. The brain and spinal marrow, which forms the cerebro-spinal axis of Meckel, and the forty-two pairs of encephalic and spinal nerves which they give off; and 2d. The ganglia and nerves of the great sympathetic or trisplanchnic system.

Of the Medulla Spinalis of Man.

—The medulla spinalis, is a cylindrical cord, slightly flattened in its antero-posterior diameter; in the adult it is on an average about sixteen inches in length, and extends from the first or second lumbar vertebra,* to the basilar foramen of the occipital bone, where it is directly continuous with the medulla oblongata, and through the latter with the cerebrum and cerebellum.

—The transverse or larger diameter of the cord, is, at the middle of the back, five lines; but at the lower part of the neck, and the lower part of the back, where the great plexuses of nerves are given off to the upper and lower extremities, it is a line or two more. It is surrounded by three membranes, like the brain; viz. the dura mater, tunica arachnoidea, and the pia mater, the latter of which closely embraces the medulla. It is enclosed its whole length in the spinal canal, the diameter of which is much

* Keuffel has seen it commencing opposite the eleventh dorsal vertebra in one case, and the third lumbar in another.

greater than that of the medulla; it does not occupy exactly the centre of the canal, but, according to Olivier, rests against its anterior wall in the vertical position, and inclines towards the posterior, especially below, when the individual rests upon his back. The consistence of the medulla is much greater when healthy and observed in the recent state, than is generally supposed; it is much greater than that of the cerebrum and cerebellum, though in general less than that of the pons varolii.

—The weight of the medulla spinalis, separated from its membranes and nerves, is in the adult in proportion to the entire mass of the brain, according to Meckel, as one to forty. Man, however, is, of all animals, the one in which the proportions of the medulla spinalis to the brain is the least; a fact, well exemplified by the comparative anatomy of the nerves, in which it will be found that the more we recede from man in the scale, the greater is the proportion of the medulla to the encephalon. The spinal medulla presents in its course two remarkable enlargements; one, superior, named cervical or brachial, which extends from the third cervical vertebra to the second dorsal, and the second, between the fourth dorsal vertebra and the lumbar, which is called the lumbar or crural. Below the crural plexus the medulla is fusiform, and terminates most generally in a point, but sometimes in a bulb, and sometimes in a bifurcation.

—The spinal cord, is divided into two symmetrical portions, that is, one for each side of the body, by the anterior median fissure, which forms a groove on its front surface, of a depth equal to one-third of the diameter of the cord, and by another groove on its back part, called the posterior median fissure, which is deep at the upper part of the medulla, but becomes quite superficial below. The anterior median fissure is more distinct and wider than the posterior. Both fissures run the whole length of the cord, and are to be found at all periods of life. In Fig. 95, are seen transverse cuts of the medulla, showing its division by the anterior and posterior median fissures, into the two symmetrical halves.

—The transverse sections of the cord show that it is solid throughout, though it has erroneously been asserted by some

anatomists to possess a canal in its centre; that its outer portion is composed exclusively of the white or fibrous neurine, and its interior contains a considerable portion of the cineritious or pulpy neurine, called sometimes the nucleus of the spinal marrow. —The quantity of cineritious or gray matter included, varies very much at different heights of the cord, as seen in the following cuts.

Fig. 95.*

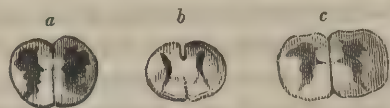
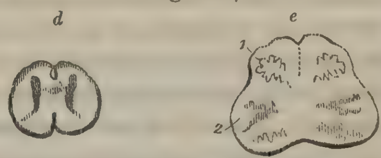


Fig. 96.†



—Every where in the spinal cord the medullary envelopes the cineritious neurine, the reverse of what takes place in the lobes of the cerebrum and cerebellum. The contrast of colour between the two substances is the more marked, the younger the subject upon which the ex-

* Fig. 95 represents transverse sections of the spinal cord at different heights, the large proportion of cineritious neurine in the centre, when compared with the medullary, and the variation in shape and size of the former, at different portions of the spine, the size being always greater at the points, where the largest number of roots to the spinal nerves are given off. The anterior surface of the cord, is represented upwards, showing the anterior median fissure; opposite to it below, is seen the posterior.

The shape of each symmetrical portion of the cineritious nucleus, is more or less semilunar; the anterior extremity or horn being blunt or round, and presenting towards the point where the anterior roots of the nerves are given off. The posterior extremity is acuminated, and terminates in the fissure from which arise the posterior roots of the nerves, and divides each half of the spinal marrow, into the posterior, and antero-lateral column. *a*, Is a section opposite the eleventh dorsal vertebra, *b*, a section opposite the fifth dorsal, and *c*, one opposite the fourth cervical.

† Fig. 96, *d*, is a representation of a transverse section of the spinal marrow, opposite the third cervical vertebra. The bulk of the cineritious neurine in this, contrasted with that of a section immediately below it, opposite the fourth cervical, (see Fig. 95,) from which the brachial plexus in part arises, is very small. *e*, Is a transverse section of the medulla oblongata, a little above the middle of the corpus olivare, showing the arrangement of its cineritious neurine, in three portions, corresponding with the divisions of the medulla oblongata, into three bodies. Both of these figures are taken from Solly.

amination is made. In old age they cease to be distinct, and become so confounded together, that the central nucleus of the medulla presents but a grayish tint, yellowish at its border where it unites with the medullary matter, which has likewise become of a yellowish colour.

—The shape of the cineritious nucleus, is in most parts like that of two)–(united thus back to back; in others it presents the appearance of four bands of cineritious matter, one anterior and one posterior on each half of the medulla.

—These four bands, or the two *c*, are very generally united together in the centre of the medulla, though Keuffel, has found those of each side entirely separate. The anterior horns or bands, do not quite reach the surface of the cord, but are exactly opposite the connexion of the anterior roots of the nerves with the spine. The posterior extend completely through its substance, at the point where the posterior roots are connected with the cord. The bulk of the cineritious matter is always larger, where the largest amount of nerves are connected with the medulla, as in the brachial and lumbo-sacral plexus. It is also relatively to the white larger in man than in any other animal. The anterior horns of the cineritious matter, are not so long, but are thicker than the posterior.

—The anterior and posterior median fissures do not quite extend into the cineritious nucleus; the bottom of the fissures is closed by a layer of white matter, which is evidently transverse in the anterior, and, as I have repeatedly seen, is formed of a sort of medullary pellicle arising from the anterior part of each half of the cord, so as to form a union or commissure between the two. The posterior fissure is closed in a similar way, notwithstanding Gall and Spurzheim have said that the fibres of the posterior commissure were longitudinal. The longitudinal appearance of the fibres is made by the tearing up of the vessels in removing the pia mater. Each of these transverse bands is pierced with a great number of openings, through which the vessels run from the pia mater into the cineritious nucleus.

—The medulla spinalis is divided, as we have seen, into two symmetrical halves, by the anterior and posterior median fissures.

Each half of the cord has connected with it upon the side, thirty-one pairs of nerves, called the spinal nerves; each nerve communicates with the medulla, (or, as is more commonly said, arises from it,) by two roots, called the *anterior* and *posterior* roots of the spinal nerves. Viewing the spinal cord, and nerves in connexion with their functions, it would be more correct to say, that the anterior roots only arise from the cord, and run outward, and that the posterior terminate there; for it has been satisfactorily proved by Sir C. Bell and Magendie, that the anterior roots are the nerves of motion, that is, conductors of the will to the voluntary muscles, and that the posterior are the nerves of sensation, conveying the impression from without through the medium of the spinal marrow, to the brain, which is the seat of consciousness.

—The fasciculi of the posterior roots are much larger than those of the anterior, and they likewise pass through a small oblong ganglion, just before their connexion with the cord, while upon the anterior there is no ganglion; upon the outer side of the ganglion the filaments of both roots are inextricably interwoven. The fasciculi of both roots of the different spinal nerves, form flattened pyramids, at the base of which they communicate with the medulla spinalis, and the pyramids formed by each root nearly touch each other at their upper and lower margin, throughout the whole length of the spine.

—The anterior arise from a superficial fissure on the external surface of the medulla, which extends throughout its whole length, and is exactly opposite the termination of the anterior horn of cineritious matter. This is called the anterior lateral fissure. Between the bottom of this fissure and the anterior horn of cineritious matter, there is nothing but a very thin lamen of medullary matter.

—The connexion of the posterior roots, is by a fissure much deeper than the former, which is called the *posterior lateral* fissure. The bottom of this fissure is formed by the projection of the posterior horn of the cineritious crescent.

—From the greater depth of this fissure, and from experiments by

vivisection upon the spine, it has been considered as subdividing each half of the spinal cord into two columns. The *anterior*, which comprises all between this posterior lateral, and the anterior median fissure, is called the motorial column, and that which is behind the posterior lateral, the sensorial column. The anterior forms a large part of each half of the cord, as seen in Fig. 97, and is frequently spoken of as the antero-lateral column. At the lower part of the dorsal, and in the lumbar region, it is one-fourth part larger than the posterior; in the cervical region it is double the size, and in the medulla oblongata, yet to be spoken of, it forms a still larger portion.

—The white fibres of the cord are very simply arranged, lying parallel to each other; in consequence of which they are easily stripped off, leaving the surface below smooth and regular, so that, as Sir C. Bell observes, "it appears that the superficial layers, furnish the roots of the higher nerves, and that the lower layers, go off to the roots of the nerves, as they successively arise."

—The cineritious matter, on making a longitudinal cut of the cord, is seen passing up, as a column of granular matter, and terminating in the oblongata, at the lower part of the fourth ventricle of the brain, between the corpora restiformia, where it forms a gray mass called by Wenzel, tuberculum cinereum. The gray matter of the cord does not, in the adult or in the embryo, present the appearance of separate, ganglionic masses, of which Gall believed it to consist. It is, however, believed by Müller, Mayo, Hall, Grainger, Solly, and others, to be entirely analogous in its offices to the nodules of the articulata, though it is not, as in animals of that class, interrupted in the intervals of the attachment of the nerves. This opinion is in accordance with the laws of developement in the inferior animals. In the pupa of some insects, the ganglia exist in an isolated state, but are made to approach each other in the more perfect developement of the animal and become fixed into a sort of spinal marrow, without any impairment of their functions.

—The function of the gray matter of the spinal cord, may

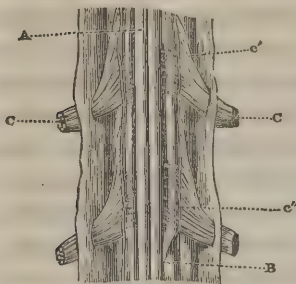
nevertheless be precisely the same in man, as though it was divided into separate masses. It has before been shown that no communication takes place laterally between the fibres of the medullary matter, however closely they may run in conjunction, their neurilematic covering isolating them from each other. The same may take place in regard to the globules of cineritious matter, each of which is surrounded and separated from the rest by a cellular envelope, and appears, as shown by the microscopical observations of Remak and Müller, to act an independent part in giving origin to an individual medullary fibre.

Connexion of the Nerves with the Cord.

—In this granular mass of cineritious substance in man and the inferior animals, there are no fibres of any description to be seen in a longitudinal section. But in a transverse cut, as has been pointed out by Bellingeri, Mayo, and Grainger, a spotted appearance is presented, in consequence of the intermixture of the white fibres with the gray substance. "The source and connexion of the white fibres," says Grainger,* "thus placed within the gray, are not known; but it is certain that they must in part, if not entirely consist of certain fibres, which pass into the gray substance from the spinal nerves." He believes the peculiar crescentic shape of the gray matter depends upon the anatomical connexion of the nerves; some of the fibres of both the anterior and posterior roots, passing into the gray substance, the junction of which is favoured by one horn being turned forward and the other backward. After repeated examination, in man and the superior animals, Mr. Grainger, appears to have fully verified the opinion, entertained by most anatomists of the present day, that the fasciculi of the spinal nerves, are more or less connected at their origin with the cineritious neurine of the spinal cord. Fig's. 97 and 98, represent the connexion of the spinal nerves with the medulla of the dog, and such as he proved it in man, in conjunction with his colleague Mr. Cooper, and Professor Bischoff of Heidelburg.

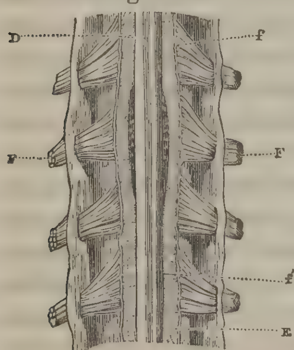
* Op. citat.

Fig. 97.



—Fig. 97 is the anterior surface of the spinal cord, where is seen the true roots of the anterior or motor nerves. *a*, The anterior median fissures, *b*, the anterior lateral. *c c*, The anterior roots of the nerves; *c'* those running up the cord to the brain, and forming part of the whole matter encircling the gray neurine, and called the cerebral or true volition fibres, and *c''*, spinal or reflex, seen dipping in the gray matter of the cord.

Fig. 98.



—Fig. 98, is a view of the posterior surface of the same cord, *d*, the posterior median fissure, *e*, posterior lateral; *f f*, posterior root of the nerves, dividing into *f'*, cerebral or true sensiferous fibres, running up on the posterior part of the cord to the brain; *f''*, spinal or incident nerves, according to Hall and Grainger, seen entering the gray substance of the cord. These roots he says are invested with the gray matter like the fibres from the crura cerebra in the corpus striatum. In Fig. 94, page 504, is seen a plan of the arrangement of the gray and fibrous structure seen in profile.

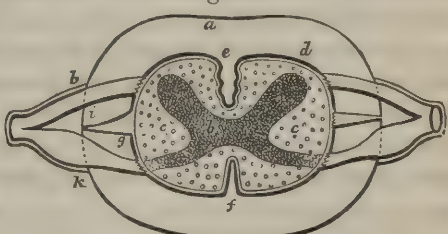
—All the parts within the cavity of the cranium to which the medulla spinalis runs, are classed under the general name of encephalon or brain, which consist of a variety of parts varying much among themselves in regard to structure and function, and which have been concisely but very clearly described in their general outlines, at page 340.

—It has there been shown that the brain and spinal marrow, are inclosed within three similar and continuous protecting membranes; the dura mater, tunica arachnoidea and pia mater, which terminate in closed sacs over the top of the brain, and in an acute extremity at the lower portion of the spinal marrow.

—The dura mater and tunica arachnoidea are analogous in structure, throughout the whole of their extent; but the pia mater is considerably modified in the spinal canal.

—The line of division established between the medulla spinalis, and the medulla oblongata, which is altogether arbitrary, is within the ring formed by the atlas vertebra, and Cruvielhier has shown, by a number of experiments, that in flexion of the head, the spinal marrow is drawn up above that level. In the whole extent of the movable chain of bones, forming the spinal column, flexion takes place in various directions, and it is to admit of that taking place, without danger of compressing the medulla, that the cavity of the long canal, and that of the spinal dura mater and arachnoid membrane, are so much larger in diameter than the medulla itself. The immediate protecting organ of the medulla in these movements is the pia mater, which in the spine tightly embraces the medulla, and which is there changed, from the delicate cellular and vascular appearance, which it presents as it descends from the brain, to a firm, resisting, fibrous membrane. A close inspection of this membrane as it exists in the spine of the elephant and bullock, as well as in man, has convinced me of a fact, which has generally escaped the observation of anatomists, viz., that it forms likewise, by a duplicature of itself upon the sides of the medulla, the ligamentum denticulatum, described in page 360, which ligament is fastened by its outer margin by processes of insertion into the dura mater.

Fig. 99.



—Fig. 99, is a drawing I have made from the cervical portion of the spinal marrow of the elephant. *a*, Is the dura mater. The arachnoid membrane is removed. *c*, The medulla spinalis. *d*, The pia mater, closely embracing the medulla, and dipping in, in the form of a fold, to the bottom of the anterior median fissure, *e*, and the posterior *f*. *g*, Its doubling forming the ligamentum denticulatum. *i*, *i*, The tooth-like processes of the ligament, by

which it is inserted into the inner face of the dura mater; the ganglion *k*, formed on the posterior root of the nerve, as well as the anterior root, is closely embraced by a process from the dura mater *b*, forming its neurilema. In this manner the medulla is always effectually maintained in the middle of the lateral diameter of the spinal canal.

Of the Medulla Oblongata.

—The medulla oblongata, (see Fig. 100, page 523,) is obviously a prolongation of the spinal marrow, as its name imports, and is the medium of communication, between all the parts of the body which receive nerves from the spinal cord and all the portions of the cerebrum and cerebellum above. Hence it has been called the central point of the nervous system, and as it gives origin to nerves, (pneumogastric, etc.,) directly connected with the performance of functions, the most immediately necessary to life, it is deserving on the part of the anatomist of the most patient study. It occupies the groove in the basilar process of the occipital bone, and is covered on its posterior surface by the cerebellum.

—It is about fourteen lines long, nine lines wide at its largest part, and about six lines thick. Below, it is continuous insensibly with the spinal marrow; above it terminates in, or rather passes through, the pons varolii, (Fig. 100,) by means of which it is continuous with the brain; and on its back part through the corpora restiformia, it is continuous with the cerebellum.

—The anterior median fissure of the medulla spinalis is continued up over the medulla oblongata; it may be traced as a superficial groove over the pons varolii, and is seen terminating in the fissure between the crura cerebri.

—The posterior median fissure extends up on the back part of the medulla oblongata, to a cavity called the fourth ventricle, where the back part of the medulla oblongata seems to open and branch off towards the cerebellum. These two fissures divide the medulla oblongata into two lateral halves, like the divisions of the spinal marrow. On each of these divisions we observe three elevations. One called the *corpus pyramidale*, from its triangular shape, which is broader above than below, and bounds

the anterior median fissure; one called the corpus restiforme, from its rounded shape, *m*, which forms the sides of the posterior median fissure as well as part of that of the fourth ventricle, where they diverge from each other to go to the cerebellum. Between the two, upon each side, is seen an oblong elevation, called the corpus olivare, *c c*, which is situated a little obliquely from without inwards, and from above downwards. These three bodies do not, however, occupy the whole surface of the medulla oblongata; between the corpus olivare and the corpus restiforme, an unelevated band of fibres is seen passing up called the corpus innominatum,* and which was first particularly pointed out by Sir C. Bell, as the *lateral column.*†

—In the account of the spinal marrow, it has been observed (page 503), that the anterior and posterior roots of the spinal nerves, have been proved unquestionably to be endowed with different functions; the anterior that of motion, the posterior that of sensation, and that the same division exists in regard to each half of the spinal column, though it has not been proved upon what part of the side of the medulla the line of demarcation exists. The deep fissure, where the posterior roots of the nerves emerge, has been assumed as dividing each half into a posterior column, and an antero-lateral. The posterior made up as experiments upon living animals would seem to show, wholly of fibres of sensation, and the latter composed on its front part, exclusively of fibres of motion; those on the back part of the latter adjoining the posterior roots of the nerves, belonging to the nerves of sensation. So that we would be justified in considering with Solly and other recent writers, that the line of division between the fibres of sensation and those of motion, is unmarked, and exists somewhere in the middle between the two orders of roots of the nerves.† The absence of any *marked* division between the motorial and sensorial columns, being no evidence against

* Sir C. Bell's divisions of each half into three columns, is no longer considered tenable.

† These parts have had the name of posterior pyramids applied to them by Rolando and Olivier. The same term has been applied by others to the corpus restiforme.

this view, as nervous fibrils, when in juxtaposition have no intercommunication. (See p. 495.)

—The two lateral fissures cannot well be traced up on the sides of the medulla oblongata, in consequence of their being obliterated by some curved transverse fibres,* with their concavity upwards, which seem to come from the corpora pyramidalia, and run over to the cerebellum. But a division of the medulla upon the side exactly between the roots of the nerves, extended upwards by tearing, in parts that have been prepared for dissection, has a tendency to separate between the corpus olivare and the corpus innominatum. So that it may be considered probable, that all in front of this division, forms the motorial column, and all behind it the sensorial. For facility of description, however, it is best to take the posterior median fissure as the line of division, and treat of the posterior column and the antero-lateral column.

—The *corpus restiforme*, is continuous with the posterior column of the cord, enlarges as it ascends, and gradually recedes from its fellow of the opposite side, and turns backwards and outwards, to throw itself into the cerebellum, of which it forms the inferior part of the crus, *e e*. The cavity left by this divergence, forms a part of the fourth venticle, (sinus quadratus,) and is in its shape resembling the letter V; the posterior median fissure extended through it, gives it the appearance of the nib of a pen, and it was therefore called the *calamus scriptorias*, by Herophilus. Part of the lateral portion called innominata, goes upwards towards the cerebrum, and part may be traced backwards, terminating insensibly on the sides of the corpus restiforme, and going with it to the cerebellum. By cutting off the corpus restiforme at the crus of the cerebellum, and stripping it downwards, we separate the column of sensation from that of motion; the cavity of the fourth ventricle is now expanded, and a mass of cineritious substance is seen exposed at top of the calamus called *tuberculum cinereum*, or *fasciola cinerea* by Wenzel, which is continuous

* These fibres have been called *arciform* or bow-shaped, by Santorini and Rolando, and by Solly, the *cerebeller* fibres of the anterior columns. But the observations of Cruvielhier, render it probable, that these fibres come from the vertical septum of the medulla, described and figured by Sir C. Bell, in the London Philos. Trans. for 1834.

below, with the posterior horn of cineritious substance in the cord, and upon the sides with the corpus restiforme, and is here increased in bulk exactly in proportion with the increase of the corpus restiforme over the posterior column of the cord.

—The antero-lateral column of the spinal marrow is continued up over the anterior and lateral surface of the medulla oblongata to the pons varolii, constantly increasing in size, and upon it are developed the corpus pyramidale and corpus olivare, a part of its fibres though, as just observed, passing off towards the cerebellum. Fifteen to eighteen lines below the pons varolii, is seen in the anterior median fissure, after the removal of the pia mater, which dips into it, a decussation of white fibres which nearly obliterates the fissure, Fig. 100. This crossing, is technically called the *decussation* of the pyramids, and is formed of three or four bands of medullary matter which cross over from each anterior column to the opposite side, then run upwards parallel with the median fissure, and constitute the *corpus pyramidale.* All the constituent fibres of the motorial part of the cord, do not share in the decussation. Those on the front and on the back part of the column, making about two-thirds of the whole, cross in bands one over another, like the fingers of the two hands when obliquely interlocked. The middle fibres of each motorial tract, passing straight up through the pons to the hemisphere of the brain of the same side.*

—On tearing carefully the corpus pyramidale from above downwards in a prepared organ, or separating it in the manner of Cruvielhier by the aid of a jet of water, it will be found that some of the decussating fibres are in contact with the gray substance, and that the inner face of the pyramid, has a column of gray neurine attached to it, which increases in bulk as it approaches

* The fact of the decussation of these fibres, which is now universally admitted, was first pointed out by Mistichelli in 1709. A decussation of the fibres had been believed to exist somewhere, as early as the times of Hippocrates and Aretæus, in consequence of injuries of one side of the head, producing very generally, palsy of the opposite side of the body. All the fibres not crossing, we are enabled to comprehend, why palsy is sometimes found to occur on the same side of the body with the lesion.

the pons, and near which it terminates abruptly; this is considered as representing in position, a portion of the anterior horn of the nucleus of the cord.

—The white fibres of the exterior, dip round the gray matter at its abrupt termination near the pons, and thus form the groove between the medulla oblongata and the pons, which is filled up with a process of the pia mater.

—On the outer side of the pyramid is placed the

Corpus Olivare,

—Which is a body of a ganglionic shape, formed interiorly of a vesicle of cineritious neurine arranged in folds, which, according to Burdach, is appended to the anterior horn of the gray substance belonging to the cord. Hence this vesicle is filled in its centre with white fibres, as well as covered on its outer surface with the white fibres, which belong to the exterior of the medulla oblongata.

—When cut through transversely as seen in Fig. 97, page 506, it presents a serrated appearance, like the *corpus dentatum* of the cerebellum, Fig. 100, page 523. By the facility with which the corpus olivare may be turned out from its position, as shown in the dissection of Mr. Solly, it appears to be a ganglionic mass, intruded as it were between the ascending fibres of the medulla, and bulging them outwards. It forms in many animals a large lobe for the origin of the pneumogastric nerves, and its office is considered by Mr. S. as exactly analogous in the human system. It appears to send up no fasciculus of fibres to the brain, except those that originate in the interior of its cineritious vesicle, and the olivary bundle of fibres of Gall and Spurzheim, which are extended into the brain, come in fact from the lateral part of the antero-lateral column, called by Cruvielhier the corpus innominatum. This has already been described, page 516, as sending off one band of fibres to join the corpus restiforme; the other is continued up, behind and around the corpus olivare,* lined on its

* The corpus olivare was considered a ganglion by Spurzheim, Prochaska, and Vic d'Azyr, though they did not attempt to determine its office. Solly considers it the ganglion of the pneumogastric nerve, part of the fibres of which, he believes to originate from it, both from the result of experiments upon it, and from analogy with its structure in the inferior animals. He considers it highly probable that it

inner or central face with cineritious substance, and enlarging as it ascends, and passing over the upper surface of the pons varolii, is expanded into the optic thalamus. It thus forms in its course the anterior wall of the fourth ventricle, and is brought into view by brushing away the tuberculum cinereum, or gray matter of that ventricle. This band constantly increasing as it ascends, has been called the *fasciculus cuneatus*, (Burdach,) and *fasciculus of reinforcement*, as it is much mixed up with gray matter on its inner face, from which it seems to derive new fibres. The arrangement of the cineritious substance of the medulla oblongata, is seen in Fig. 98, *e*, page 507.

—It will thus be seen that the medulla oblongata, is very complicated and intricate in its interior structure. It has been variously described by different anatomists, and is not yet probably thoroughly understood. Its anterior or motorial fibres appear evidently directed upwards towards the cerebrum; its posterior or sensiferous pass backwards and outwards as the corpus restiforme, (inferior peduncle of the cerebellum) to the centre of the cerebellum, where it meets with a cineritious mass, called the corpus dentatum, Fig. 100, from whence its fibres are radiated in increased numbers, to the circumference of the cerebellum, from which they have been considered by Foville as again reflected inward, to be converged into the crus cerebelli of each side, and continued on to form a part of the structure of the pons.

Of the Cerebellum.

—The cerebellum lies below the posterior lobe of the cerebrum, in a cavity inclosed below and behind by the sphenoid and occipital bones; laterally by the petrous portions of the temporal bones, and above by the tentorium. It measures transversely at its greatest breadth, from three inches ten lines, to four inches; longitudinally in the centre, twenty lines; either lateral portion

is a central point upon which is received the organic sensations arising from the lungs, and from which emanates that peculiar imperative power, which the system of respiratory nerves conduct, and by which they call the muscles of respiration into action, without the agency of the will. This is very probably the case in regard to a portion of the fibres of the pneumogastric, forming its reflex system of nerves; other fibres in all probability pass up into the brain, to constitute the cerebral sensiferous and motorial portion of this nerve.

is about two inches long, and about sixteen lines thick at its middle. The lateral parts are called lobes or hemispheres. The central part, from being the first part of the organ developed in the inferior animals and in the human fœtus, is called the fundamental portion by Gall and Spurzheim.* It consists of two portions, the inferior and superior vermiform processes, so named from the transverse ridges upon the surface, which give them the appearance of a worm. The anterior portion of the superior vermiform process is elevated, and is called *the monticulus.*

—When viewed from above the two hemispheres are externally circular, and at the place where they are joined to the central portion, they are deeply notched before and behind; hence they form two fissures in the median line; one looking towards the cerebrum, and receiving the tubercula quadrigemina, *g*, Fig. 101, termed the semilunar fissure, the other backwards, which receives the falx cerebelli, called the purse-like fissure, from its narrowness at first, and its subsequent enlargement. Reil, employs the term horizontal or lateral fissures, to designate those depressions which extend transversely across the fore part of the cerebellum, and contain the processes passing to the pons varolii.†

—These fissures are continuous with the intervals between the upper and under posterior lobes, which extend as far as the purse-like fissure. Thus a deep furrow may be traced all round each hemisphere dividing the cerebellum into an upper and under portion. Each hemisphere has five lobes, two on the upper, and three on the under surface; these are separated from each other by deep furrows or fissures, which pass in to the central medullary nucleus, as seen in Fig. 101, in which is represented a vertical section of one hemisphere.

—Each one of these lobes, is subdivided, as we may see, into a number of lobules, by a series of smaller furrows. These are found on the periphery of the lobes, and on the sides of the large fissures which separate them from each other, and each one of these lobules again is formed of a number of horizontal leaflets.

* Reil considered this central part, a general commissure, but this is evidently an error, for we find this part sometimes constituting the whole cerebellum, as in rabbits, where there are no lateral lobes to connect.

† Reil, Mayo's Translation, Anat. and Med. Commentaries.

Each leaflet is composed of a folded layer of cineritious neurine, half a line thick on its outer side, and of a medullary layer within. The cineritious coverings of the leaflets are all continuous together, so that each hemisphere of the cerebellum has a cortical covering of cineritious matter, with a superficies equal to that of a sphere twenty inches in diameter, but folded up in a compact mass, to suit the narrow space in which it is lodged in the cranium. —The medullary matter contained in the leaflets of each lobule, are radiations from a larger medullary mass at the base of the lobule, called a twig. The medullary twigs of each lobe, are derived in a similar way from larger white masses, called branches, and the branches again form a large medullary mass in the centre of each lobe called the trunk. The whole of this beautiful arrangement of the medullary matter, forms what is called fancifully, the *thuya*, or *arbor vitæ.* Anteriorly the trunk of the arbor vitæ or the medullary nucleus, advances towards the medulla oblongata, inclosing laterally the fourth ventricle; each trunk then divides into three processes or *pedunculi;* one pair passes to the testis of the tuberculi quadrigemina, called peduncle of these bodies, and forms a part of what is called the *valve of Vieussens, valve of cerebellum, processus e cerebello ad testes, oblique or intercerebral commissure* of Solly; a second pair to the medulla oblongata, *corpora restiformia,* and a third pair, over the lower surface of the pons, called its peduncle or the great commissure of the cerebellum. Under the term crus cerebelli, all these three parts are commonly, though inaccurately comprised.
—Each one of the lamina or leaflets of the lobes of the cerebellum, are susceptible of being unfolded in a properly prepared part, and spread out so as to form a flat membrane, with a cineritious covering on its outer side, and a medullary layer within, consisting of parallel fibres, which can be traced down to the central medullary twig of each lobule. The last part of the stratum consists of coarse and curvilinear fasciculi, which constitute the central mass of medullary matter of each hemisphere (trunk of the arbor vitæ), fibres of which may be raised up in a properly prepared cerebellum with the forceps, in fine filaments the size of the thread of a silkworm.

—The fibres of the peduncle of the pons, that is, of the lateral part of the crus cerebelli, which forms the great commissure of the cerebellum, according to Reil, can be traced backwards, outwards and inwards, upwards and downwards, so as to appear to go to almost every part of each hemisphere of the cerebellum. The fibres of the corpus restiforme, when isolated, appear to pass in a similar direction. A vertical section of any part of the cerebellum, will show the arborescent arrangement of the white matter, (Fig. 101;) but a section to exhibit the corpus dentatum, must be made at the inner side and in the course of the fibres of the corpus restiforme, which is in favour of the view of Gall, who considered the corpus dentatum as a ganglion of reinforcement to the corpus restiforme, and called it the ganglion of the cerebellum.*

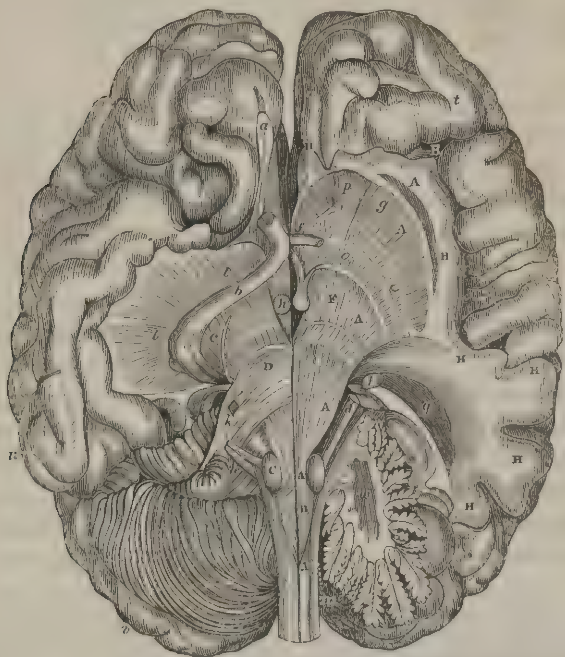
—We have followed Reil in the main, in his description of the cerebellum, as it involves no theory in respect to its formation; but it appears equally probable, that the views of Gall lately elucidated by Foville, are equally correct; viz. that the cerebellum is developed by diverging fibres which proceed from the corpus restiforme to the circumference of the organ, and then are reflected inwards or converged to form the peduncle of the pons, and that of the tubercula quadrigemina.

—From this description it will be seen that the medulla oblongata, is formed of four plans of different fibres; that of the corpus pyramidale, that of the corpus olivare, that of the *medullary lamen* of Sir Charles Bell, (*corpus innominatum*,) and fourthly, that of the corpus restiforme. The first one is formed of the anterior or motorial column exclusively; that is, of the column between the anterior roots of the nerves, and the anterior median fissure. The second starts from the ganglionic mass of the corpus olivare and seems to run with the fibres of the third bundle behind it. The third formed of one half or what is considered the motorial part, of the lateral column of Sir C. Bell, (and which he considers the cerebral strands of sensation,) and the fourth, formed of the posterior and sensorial half of this lateral column, united to the

* The best method of unravelling a lobe, is that of Reil. A portion about an inch broad is to be cut out of a fresh cerebellum, and placed for twelve or twenty-four hours in a weak solution of caustic potash, then in distilled water for some hours more, and finally left from twenty-four to forty hours in pure alcohol.

posterior column of the spinal marrow, which forms the corpus restiforme.

Fig. 100.*



* Fig. 100, is a representation of the cerebellum, and a part of the base of the brain, showing especially the course of the anterior columns of the spinal marrow, to their termination on the hemispherical ganglia. *A*, *A*, Antero-lateral column of the cord continued on to the hemispheres of the cerebrum. *B*, Corpora pyramidale, the decussating fibres of which are seen. *C*, Corpora olivare. *D*, Pons varolii. *F*, Crus cerebri. *g*, Anterior cerebral ganglion or corpus striatum. *H*, Cineritious or cortical neurine of the hemispheres, forming what have been called the hemispherical ganglia. *I*, Cerebellum. *a*, Olfactory nerve. *b*, Optic nerve; on its outer side, *l*, *l*, are seen the white fibres expanding into the base of the middle lobe. *c*, Fourth nerve. *d*, Sensory root of the fifth pair of nerves. *e*, Roots of the facial and auditory nerves. *f*, Anterior commissure. *h*, Eminentia mammillaria; on the left side the cineritious matter is scraped away so as to show the origin of the fornix from it in front, and a medullary band going to the inner face of the optic thalamus. *i*, Corpus geniculatum externum, from which the root of the optic nerve has been cut. *k*, Trunk of the fifth pair as it emerges through the transverse fibres of the pons, *D*, which form the commissure of the cerebellum.

—The corpus restiforme, has been traced backwards into the cerebellum, and there is much reason to consider it as forming a doubling there, and coming forwards again as a part of the pons varolii. The other three columns we can trace upwards through the interior of the pons varolii, and crura cerebri, to the brain.

Pons Varolii.

—By dividing the transverse fibres on the lower surface of the pons, which come from the cerebellum, to the depth of about one-eighth of an inch on the middle line, and then scraping them back towards the cerebellum, the fibres of the corpus pyramidale will be seen crossing through the pons varolii, and emerging beyond it, from its anterior or upper edge, traversing the under part of the crus cerebri, *F*, Fig. 100, a part of the thalamus opticus, and finally expanding in the corpus striatum *g*, to concur in the formation of the lobes of the cerebrum. The divergence of the crura, forms the posterior boundaries of the lozenge-shaped cavity of the base of the brain. The fibres of this fasciculus are separated from each other in their course through the pons, by gray matter, and the fasciculus appears in consequence to increase in its breadth. According to Tiedemann, the transverse

On the opposite side, these transverse fibres have been removed, to exhibit the passing of the fibres of the anterior column, from the corpus pyramidale, which begin to diverge and to be reinforced.

On the left side, the brain being inverted, is seen a vertical section of the cerebellum, made through the entrance into it of the corpus restiforme *m*. (Posterior column of the spinal marrow.) *w*, Corpus dentatum or ganglion of the cerebellum, showing the augmentation of the corpus restiforme in the ganglion, and from which the medullary branches and twigs divide to the leaflets of the cerebellum. The whole of this medullary arrangement, constitutes the arbor vitæ. *o o*, Nervous fibres cut off, which spread out from the thalamus into the convolutions of the middle lobe. *p*, Medullary fibres which pass through the corpus striatum, reinforced as they proceed to the anterior lobe. The middle lobe of the brain on this side is entirely removed, which exposes the side of the great lateral ventricle, *q*. In front of it a small section of the anterior lobe is seen, and the fibres which radiate into that lobe from the ganglia. *R*, Inner termination of the fissure of Sylvius, from which the middle lobe has been cut, showing its proximity to the corpus striatum in the central part of the brain. *s*, Fourth pair of nerves. *t t*, Anterior lobe of the cerebrum. *u*, Middle lobe. *v*, Posterior lobe. On the right side, just below the corpus olivare, are seen the arciform fibres of Santorini. In front of *e* is seen the auditory and facial nerves.

fibres of the pons, forming what has been called the commissure of the cerebellum, are seen in the fœtus, to form a junction with the ascending fibres of the corpus pyramidale.

—The fibres composing the anterior half of the lateral column (*corpus innominatum*) ascending principally to the outer side, or back part of the corpus olivare, plunge into the pons varolii, form the floor of the fourth ventricle, and pursue their course through the crus cerebri, *F*, to their appropriate ganglion in front of *F*, the *posterior cerebral*, *o*, *o*, better known under the inappropriate name of *thalamus nervi optici.* These fibres form the upper part of the crus cerebri, and are separated in that body, from the ascending fibres of the corpus pyramidale, by a deposit of dark-coloured cineritious matter, called the locus niger of Sömmering. This tract, which is considered sensory by Bell and Solly, and motory by Foville,* is covered above where it forms the upper part of the crus cerebri by the valve of Vieussens, and the tubercula quadrigemina *g*, Fig. 101. The course of these fibres through the posterior cerebral ganglion (*thalamus*) is not so distinctly marked, as those of the corpus pyramidale *B*, Fig. 100, through the *corpus striatum*, or anterior cerebral ganglion. They are more intimately intermixed with the cineritious substance in the centre of the posterior ganglion. From the outer side of this ganglion, the medullary fibres are seen issuing forth, and spreading in every direction to terminate in the cineritious outer covering of the cerebrum, which Solly calls the hemispherical ganglion. The pons, it will be seen then, as its name imports, is a sort of bridge between the medulla oblongata, cerebrum, and cerebellum, formed of transverse fibres coming from the cerebellum, particularly well marked on its lower surface, and of the ascending fibres of the medulla oblongata; and on its upper surface of the valve of Vieussens, or oblique commissure, which passes from the cerebellum to the tubercula quadrigemina, bodies which are placed on the back of the pons: including within it immediately below the valve of Vieussens, the fourth ventricle, or ventricle of the cerebellum, from which a canal called the *aqueduct* of *Sylvius* or *iter e tertio ad quartum ventriculum*, is extended up to

* Encephalon, Dict. de Med. et de Chir. Pratiques.

the third ventricle, which we shall find located between, and extending a little above the crura cerebri. Among the white fibres constituting the pons, there is likewise intermixed a considerable quantity of cineritious matter.

The Valve of Vieussens,

—Arises from the central or fundamental portion of the cerebellum and is extended upwards to the lower two bodies of the tubercula quadrigemina—the testes—is attached to the side of the pons, and part of its fibres passes under the tubercles to reach the testes. It has therefore been called inappropriately the processus cerebelli ad testes, and ought rather to be called the *processus cerebelli ad cerebrum.* It covers in its course the top and sides of the fourth ventricle, is formed of a medullary lamen on its outer face and of a cineritious layer on its inner. The cineritious matter is thickest at the middle portion of the valve, where its structure is least resisting, and from whence arises the fourth pair of nerves.

—The *crura cerebri F*, Fig. 100, formed in the manner described, are cylindrical, and closely approximated at their origin from the anterior and upper part of the pons. They are about six lines long, and six lines thick; and as they pass up the column of fibres, from which the hemispheres of the cerebrum are developed, they recede from each other, so as to approach the middle of each hemisphere, where they terminate in the corpora striata and thalami nervorum opticorum. They flatten themselves as they recede from each other, and leave a cavity necessarily between them, which forms a part of the third ventricle. The commissure of the optic nerves, bounds them in front, and the triangular cavity left by their divergence below is filled up by the *tuber cinereum*, (pons Tarini) surrounding the base of the eminentiæ mammillares *h*, Fig. 100. Into these passes up a band of white matter, which comes from the corpus innominatum or lateral portion of the medulla oblongata.

—The *tubercula quadrigemina*, (lobi optici of animals, see Fig. 101,) are four tubercles placed upon the top of the pons, upon which they rest by their lateral borders, and form an arch over the aqueduct of Sylvius.

—They form two pairs; the superior called the nates, the inferior called the testes. These bodies are rather small and rudimental in man, but large in the inferior animals. They contain in their interior some cineritious matter, and are covered on their outer surface, by medullary fibres. Their direction is obliquely forwards and upwards. The posterior tubercles are the smallest, nearly hemispherical in shape, and are separated from the anterior by a transverse groove. This groove is crossed by another in the antero-posterior direction, which separates the two bodies of the right, from those of the left side.

—Upon the nates terminates the valve of Vieussens, and a *triangular medullary fasciculus*, from the side of the pons; the latter of which comes from the fascia innominata of the antero-lateral column. The fibres from these bodies, pass up through the tubercles, appear to be reinforced in the gray matter, and expand into the optic thalamus, with which the nates is continuous in an oblique direction, though partially separated from it by a slight groove. From the anterior extremity of the nates, part some medullary fibres, which form a thin layer over the *corpus geniculatum externum* of the thalamus, to assist in the formation of the optic nerve.

Of the Cerebrum.

—The cerebrum is that portion of the encephalic mass, which occupies all the cavity of the cranium, with the exception of the fossa, formed on the inferior portion of the occipital bone. It forms, as it were, a sort of efflorescence or expansion on the top of the spinal column, into the centre of which on each side, (*corpus striatum* and *thalamus opticus*,) we have now traced all the fibres of the medulla oblongata and cerebellum. The volume of the cerebrum, which is peculiarly large in man, is from eight to twelve times greater than that of the cerebellum.*

—The *corpus striatum*, *anterior ganglion of the cerebrum*, and

* In three young subjects, Cruvielhier found the weight as follows:—

	lbs.	oz.		oz.
Cerebrum, weighing	2	2	Cerebellum,	4½
" "	2	8	"	3½
" "	2	5	"	5

the *thalamus nervi optici*, posterior ganglion of the cerebrum, receive the fibres coming from the spinal marrow, and are continuous with those from the cerebellum. The *corpus striatum* is placed in front and slopes obliquely upwards, forwards, and outwards, in the direction of the anterior and middle lobes of the cerebrum, and thus receding from its fellow of the opposite side, contributes to form the cavities called the lateral ventricles; it is about two and a half inches long, and about an inch broad at its anterior termination, and is terminated in a tail-like process behind, which embraces the upper portion of the thalamus. The *thalamus* is placed more posteriorly; it is about two inches long and one broad, and is sloped downward and backward in the direction of the posterior lobes of the cerebrum, and the posterior part of the middle lobes; by receding from its fellow of the opposite side, it forms the upper and lateral boundaries of the third ventricle. It is covered with medullary fibres on its outer face, and presents four rounded elevations. Three of these are found at its posterior extremity; one is above the other two, and is called the *tuberculum posterius superius;* those below consist of the *corpus geniculatum internum*, and *corpus geniculatum externum;* and there is one in front called *tuberculum anterius.* Its interior is composed of cineritious neurine, which is continuous between the organs of the two sides, forming the *commissura mollis* of the third ventricle. The corpus striatum is cineritious on its upper surface, or that which presents to the ventricle, and is made up in its interior of alternate strata of cineritious and medullary neurine, which gives it when divided vertically a striated appearance, from which it has received its name. The cineritious neurine in both these organs, is marked with white medullary lines, which Gall first described as the origin of new medullary fibres reinforcing those which come from the medulla oblongata, to be expanded into the cerebrum. Hence he assigned them the names of ganglia of the cerebrum.

—From all points of the surface of these two ganglia, except those which form the walls of the ventricles, medullary fibres radiate in all directions, forming the solar rays or *fan* (*eventail*) of Vieussens, and the radiating crown of Reil. Many of the fibres which emerge from the thalamus, pass also through a por-

tion of the corpus striatum, and seem bridled, as it were, by the curvilinear band of white fibres called *tenia strata*.

—The fundamental point in the anatomy and physiology of the cerebrum, consists in determining the ulterior course of the fibres which radiate from these two ganglia, *corpora striata*, and *thalami optici*, in order to constitute the convolutions of the cerebrum, and the various bands which connect the different parts of the brain together. This has not yet been satisfactorily accomplished.

—Gall and Spurzheim, have considered them as passing off as bundles of diverging rays, in the form of inverted cones, to the outer or cineritious covering of the hemispheres, (hemispherical ganglia,) and that new fibres from the termination of these, or the same reflected inwards, pass subsequently in an opposite direction under the name of converging fibres to form the commissures. Tiedemann and Foville, with at least equal reason, have considered the hemisphere of each side as formed of a layer of medullary fibres, in the form of a sac, the commencing point of developement of which as seen in the fœtus, is at the sides of the corpus striatum and optic thalamus; the fibres of the sac being covered on its outer face with the granular cineritious neurine, and the whole folded and plaited, so as to present on the exterior the appearance of sulci and convolutions, and to be susceptible of being packed away, in the narrow compass of the walls of the cranium. In either view of the case, each convolution will consist of four layers, two exterior and cineritious, two interior and medullary; the latter of which may readily be separated by a jet of water *in the middle line*.

—The *corpus callosum*, or (*commissura magna cerebri*,) is evidently formed in part by a band of white fibres which proceeds from the upper and outer margin of the thalamus and corpus striatum, turns inwards and passes transversely over to the middle line of the body, to unite in some way which is not fully understood, with a similar band from the opposite side; forming an arch or vault over the thalamus and corpus striatum, which constitutes the roof of the lateral ventricles. The remaining part of its structure consists of a layer of white fibres on its

exterior, which evidently come in from the hemispheres of the cerebrum, as may be seen in an attempt to separate the parts from above downwards.

—On the top of the tubercula quadrigemina, is seen a small conoidal mass of cineritious matter, called the *pineal gland*, (conarium,) which usually after the seventh year of life, contains some particles of gritty or sabulous matter. From it, extends a small band of medullary matter to each thalamus. The use of this organ is not known. Descartes considered it, absurdly enough, the seat of the soul, after other uses had been found for the corpus striatum, fornix, and other parts, for which at different periods the same high office had been assigned. Solly is disposed to consider it with its peduncles a commissure between the thalami, and which he calls the pineal commissure. Above this body, and between the tubercula quadrigemina and back part of the corpus callosum, is the *great lateral fissure* of Bichat, where the pia mater and tunica arachnoidea of the cerebellum and posterior lobes of the cerebrum are extended into the ventricles in the interior of the brain. A portion of it envelopes closely the pineal gland, and is extended over the top of the third ventricle, forming the *velum interpositum*, and down the middle cornua of the lateral ventricles, forming the *plexus choroides*. The so called posterior commissure of the third ventricle, is formed merely by the bulging forwards of the white fibres of the nates, in consequence of the cineritious developements within.

—The *Fornix*, (*inferior longitudinal commissure*,) is extended over the upper surface of the velum interpositum. It has the shape of a vaulted roof, as its name imports, and forms the roof of the third ventricle, and part of the lower surface of the two lateral. It arises by two rounded cords called the anterior pillars of the fornix, from the *eminentiæ mammillares* (*bulbæ fornicis*) which are two bodies at the basis of the brain, (see Fig. 100,) medullary externally, and cineritious within, and into which fibres extend both from the ascending columns of the medulla oblongata, and from the interior of the thalamus.

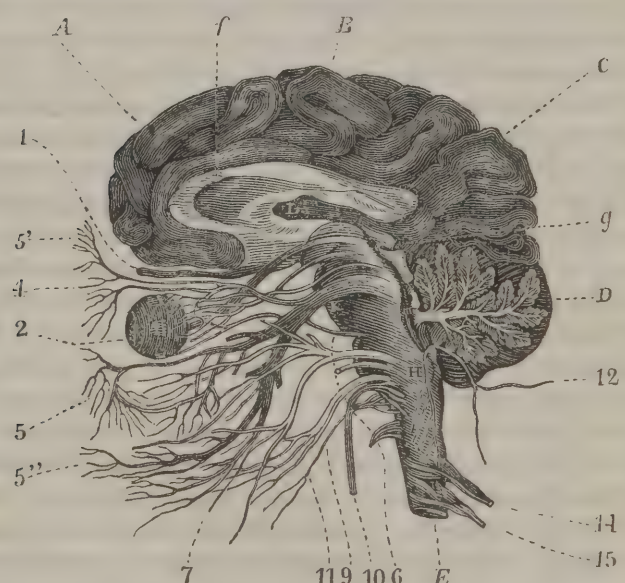
—The course of these cords, is first forward, then upward, and then backward, forming a semicircle, concave posteriorly, former-

ly called the anterior pillar of the fornix, the back surface of which is free and unattached, while the front convex surface, receives fibres from the anterior lobes and from the under part of the great transverse commissure, *by which means a thin delicate septum is formed, called septum lucidum.* The fornix in its passage backwards under the corpus callosum, to which it is attached, spreads laterally, and at first is nearly of the width of half an inch; but afterwards becoming much wider, it descends to be connected with the convolutions, first of the back part, and afterwards of the inner and under part of the posterior lobes. While tracing its fibres in this portion of its course, two projections are observed which have received the absurd appellation of hippocampus major and minor, which are usually described as distinct bodies, situated in the descending and posterior cornua of the lateral ventricles. When carefully examined in a brain that has been well hardened in alcohol, the hippocampus major, will be found to consist of cineritious neurine, covered by a thin layer of medullary fibres. This cineritious neurine is a part of, and continuous with, the external coat of the cerebrum. It is a part of a convolution. The medullary fibres come from the under part of the cerebrum, in various directions, and being collected at the inner edge of this body, form what have been usually called the posterior pillars of the fornix, or the tenia hippocampi, but which we must regard as the posterior and descending extremity of the commissure. The cineritious neurine over which the fibres of the fornix pass at its anterior inferior, and posterior inferior extremities, is in fact but a continuation of that neurine which forms a part of the hemispheral ganglia; that is, a part of the convoluted surface of the brain, but in this situation covered by the inferior fibres of the longitudinal commissure. In this way the real character of hippocampus has been observed.*
—The hippocampus minor, is in some respects analogous to the hippocampus major, for it is formed by the projection of one of the fissures, dividing the convolutions at the inner side of the posterior lobe, where it is covered by the posterior fibres of the

* Solly, op. citat.

longitudinal commissure. It differs from the hippocampus major in this respect, that the projection is caused by the central surface of the convolutions, and not by the hemispherical ganglia as is the case in regard to the hippocampus minor. It will thus be seen that the fornix serves to connect together, many portions of the hemisphere of the same side as the corpus callosum does those of the opposite sides. Several other commissures of less magnitude are described in the cerebrum, viz. the middle commissure of the third ventricle as it is called, formed by the union of the cineritious substance of the two thalami; the anterior commissure of the third ventricle, which passes across between the corpora striata, and the neighbouring parts of the cerebrum, in front of the anterior crura of the fornix, and which sends some filaments which arch forwards to the origin of the olfac-

Fig. 101.*



* Fig. 101, is a vertical section of the cerebrum, cerebellum and medulla oblongata. *A*, Anterior lobe of the brain. *B*, middle lobe. *C*, Posterior lobe. *D*, Cere-

tory nerve; the superior longitudinal commissure described by Mayo as running along the sides of the longitudinal fissure, above the corpus callosum, to connect together the convolutions placed above that part, and the intercerebral commissure or valve of Vieussens, which has already been described. A lateral view of the different parts of the brain, is seen in the vertical section opposite, as well as the position of the ventricles, the channel of communication between them, and the relative position of the encephalic nerves at their origin.

—The *infundibulum* is a funnel-shaped reddish cineritious cord, two and a half lines long, which seems to spring from the tuber cinereum at the base of the third ventricle, and terminates on the pituitary gland. It presents an open cavity on the side of the third ventricle, and in the fœtus communicates with the cavity in the gland; after birth its inferior extremity appears to be closed. Some medullary fibres have been traced from it to the optic nerve. It is closely embraced by the pia mater.

bellum. *E*, Medulla spinalis. *H*, Medulla oblongata. *K*, Pons varolii. *L*, crus cerebri. *f*, Section of the corpus callosum, which is situated at the bottom of the fissure, separating the two hemispheres of the brain. *g*, Optic thalamus, of which the back part only is seen. The corpus striatum is placed in front of it though not seen in this figure, and at the bottom of the dark space which forms the lateral ventricle. Below the thalamus is seen the section of the tubercula quadrigemina, (the superior eminence of which is called the nates, the lower, testes,) and below that again the valve of Vieussens; which arises from the medullary layer of the central portion of the cerebellum, *D*. Below the corpus striatum is the lateral ventricle. Between the optic thalamus and the crus, is seen the third ventricle; (the fornix which separates these two ventricles, and the septum lucidum have been removed.) Between the tubercula quadrigemina and the pons is the aqueduct of Sylvius, or the passage from the third ventricle, to the fourth, which forms the cavity, *m*, between the cerebellum and the medulla oblongata. 1, Olfactory nerve. 2, The eye, upon which terminates the optic nerve, the root of which may be traced back over the crus cerebri to the optic thalamus, and the nates. Next below the optic is seen the third pair of nerves, motor oculi. 4, The fourth pair running to the superior oblique muscle of the eye. 5, Superior maxillary branch of the fifth pair. 5', Ophthalmic branch of the fifth pair. 5", Inferior maxillary branch of the fifth pair. 6, Sixth pair, or motor externus. 7, Facial or portio dura; below the origin of this is seen the trunk of the auditory nerve, or portio mollis. 9, Glosso-pharyngeal. 10, Pneumogastric. 11, Hypo-glossal. 12, Spinal accessory of Willis. 14, 15, Cervical nerves. The ophthalmic ganglion is seen near the eye at the outer side of the optic nerve.

—The *Pituitary gland* or *hypophysis cerebri*, is a small body weighing about ten grains, placed in the cavity of the sella turcica of the sphenoid bone, where it is closely embraced upon its side and part of its upper surface, by the processes of the dura mater, forming the cavernous sinus, which is reflected into the cavity of the sella turcica, and forms a capsule to the gland.

—It consists evidently of two lobes, an anterior and posterior, as may be seen in the human subject. It is large, and may be studied to advantage in the calf, where it forms a body about an inch long, and five-eighths of an inch wide. The posterior lobe is about a third the size of the anterior, and receives the apex of the infundibulum, through an oval opening left in the dura mater. It is conoidal in front, and received in a corresponding cavity of the anterior lobe, between which is reflected a partition of cellular tissue from the side of the capsule that is very vascular. The large lobe is cineritious and granular in its centre, and medullary on its outer face.

—The posterior is of a grayish-white colour, and presents two eminences, one, which is continued forwards to the cineritious centre, of the anterior lobe, and one, which in the calf is evidently fibrous, and continuous backwards with the infundibulum. The use of this organ is not understood; in the human fœtus, it is larger at the fifth month of intra-uterine life than at birth. It is proportionably larger in the inferior animals than in man, and in fishes it forms a large lobe with a cavity in its centre. Wenzel asserts that he has frequently found it diseased in epileptic subjects; and latterly Arnold has traced to it, several branches of the sympathetic nerve which seem to originate from it.

On the Immediate Origin of the Encephalic Nerves.

—By reference to Fig. 101, it will be seen that all the encephalic nerves, (with the exception perhaps of the olfactory,) originate from portions of the base of the brain, into which has been directly traced the fibres of the spinal cord. The nerves arising from the spinal medulla, have been shown to consist of two distinct classes, those of sensation and those of motion, and that each of these is, in all probability, subdivided into nerves, which are reflected at their origin from the gray substance of

the spinal cord, without connexion with the brain, called the *reflex*, or *excito-motor* system of nerves, and those which are directly continuous with the brain, called the sensiferous or cerebral. The encephalic nerves may be justly considered as originating much in the same manner, with the exception that their sensitive and motor roots, are, in general, continued on as distinct trunks, to their termination in the organs.

—Their origin is derived in a great part from the medulla oblongata, which contains a large amount of cineritious matter, and from which there is reflected a greater amount of nervous fibrils, than from any similar bulk of the spinal cord; some of their fibres being also continued upwards to the brain, like the sensiferous of the spinal cord. If it were possible to isolate distinctly the sensory from the motory fibres of the nerves, it would be better to describe them in the direction in which they act, the sensory from without inwards, and the motory from the central organs towards the circumference. As this cannot be done, they are considered from convenience of description, as all originating from the central organs.

—The hypoglossal arises by three roots, which emerge by a number of minute filaments from the anterior columns of the medulla oblongata, and is a motor nerve.

—The spinal accessory of Willis, as has been observed, (page 464,) arises from the cervical portion of the spinal marrow, passes up through the occipital foramen, and goes out from the cavity of the cranium in conjunction with the par vagum, and has been considered as associated with the latter as a motor nerve for the external respiratory muscles.

—The *pneumogastric* or *par vagum*, is a mixed nerve in its distribution, in consequence of its receiving motor filaments from the spinal accessory and other nerves, which are wrapped up in its general sheath; it is believed, however, to be a sensory nerve, entirely, at its origin from the lateral tract of the medulla oblongata, immediately behind the corpus olivare, where it consists of from seven to fourteen flattened fasciculi.

The *glosso-pharyngeal*, is believed to be a compound nerve, giving nerves of sensation to the mucous membrane of the back

part of the tongue, and nerves of motion to some of the muscles of the pharynx. It originates by two roots, which seem to come partly from the lateral tract, and partly from the corpus olivare, immediately above the pneumogastric. It has been considered the special nerve of taste; but the nerve of taste appears not to be a distinct trunk. The fibres endowed with this function, are probably included in the branches of the glosso-pharyngeal and the fifth.

—The *auditory nerve*, is exclusively one of sensation; it originates by two roots, one of which passes through the substance of the medulla oblongata, and takes its origin from the corpus restiforme. The other winds round the restiform body, and arises from the medullary striæ in the cineritious substance of the fourth ventricle.

—The *facial nerve*, is considered the principal motor trunk to the fifth pair. It emerges from the groove between the corpus pyramidale and olivare, but which may be traced backwards according to Solly, through the pons varolii, to the inner side of, and in contact with, the sensory root of the fifth pair of nerves. It then divides into two roots; one arising from the motor column of the spinal cord, and the other from the cerebeller or arciform fibres of the anterior column, (see Fig. 100.)

—The *motor externus* or abductor oculi, proceeds from the anterior part of the corpus pyramidale, and is exclusively a nerve of motion.

—The *trigeminus* or fifth pair, is partly a mixed nerve, and arises by two roots, one for sensation and one for motion. The former called the *portio major*, emerges, from between the transverse fibres of the pons varolii, and can be traced down through the medulla oblongata, to the posterior columns of the spinal cord, an inch and a half below the pons. The portio major, forms exclusively the *ganglion of Gasser;* upwards of a hundred filaments have been counted in this root.

—The *motorial root*, portio minor, traverses the pons by a distinct root, and appears to originate from the valve of Vieussens, (*intercerebral commissure.*) These motor fibres join the third

branch of the fifth pair, beyond the ganglion of Gasser, and supply the muscles of mastication.

—The patheticus or fourth pair, arises from the valve of Vieussens, near the tubercula quadrigemina, where it is placed in close connexion with other nerves going to the eye and its auxiliary parts, viz., the optic and the motor oculi communis.

—The *motor oculi communis*, or third pair, emerges from the inner side of the crus cerebri, but it takes its rise by two roots; one of which can be traced in to the *locus niger* of the crus, and is there continuous with the ascending motor columns of the medulla oblongata; the other passes round the outer margin of the crus, just in front of the pons, and is closely connected with that part of the origin of the optic nerve, nearest the peduncle. This is called the accessory root of Rolando. It is particularly well developed in the bullock. This nerve sends a large root to the ophthalmic ganglion, from which the ciliary nerves are derived. It appears to be the motor nerve of the iris, for when, in the experiments of Mr. Mayo, the third pair was irritated, the iris was observed to contract.

—The *optic* or second pair, tracing it from its *chiasm* backwards, (where the inner half of the fibres of each nerve seem to cross over to the opposite side,) winds round the crus cerebri, to which it is attached by a thin medullary lamen at its outer edge. As it reaches the thalamus the nerve is divided into two roots, one of which arises from the *corpus geniculatum externum* of that organ; the other passes over the corpus geniculatum internum to which it is slightly connected, to arise by two slips from the tubercula quadrigemina—one from the nates, and the other from the testes. This latter is the principal origin of the nerve in animals; hence the tuberculi quadrigemina have been called the optic tubercles.

—The *olfactory* or first pair of nerves, appears to originate by three roots, near the fissure of Sylvius, close to the substance of the corpus striatum, one of which is connected with the anterior commissure of the middle ventricle; this nerve runs out in a triangular groove on the lower surface of the anterior lobes, to its bulb, by the side of the crista galli of the ethmoid bone. The structure

of the bulb is cineritious and pulpy in man; and in the inferior animals, as the horse and sheep, it is of a similar structure, and forms a large olfactory lobe, with a ventricle within it. It would therefore in man be more correct, as Blainville and Rolando have observed, to consider the bulb as an olfactory lobe or ganglion, from which the true olfactory nerves are spread into the Schneiderian membrane, and the grayish cord extending back from it and ordinarily called the nerve, as but a commissure to connect it with the brain.*—

* The student will find his progress, in the difficult study of the nervous system accelerated by the possession of preparations upon which the nerves have been prepared and dried; or, which is next best, by drawings, which, at the same time that they are kept in the main true to nature, give to the subject, something of the clearness of a diagram. In the latter respect, the student will find an excellent assistant in the "Plates of the Cerebro-Spinal Nerves, with references," by Dr. P. B. Goddard; in Manec's two plates, of the cerebro-spinal axis, and sympathetic nerve, the size of life; and in Professor Lobstein's treatise, "De structura, usu, et morbis, nervi sympathetici," etc., the three last of which have been translated with additions, by the editor.

GLOSSARY.*

EXHIBITING THE DERIVATION OF CERTAIN ANATOMICAL TERMS.

A.

Acetabulum. The cavity which receives the head of the thigh-bone; from *acetum* vinegar; so called, because it represents the acetabulum or saucer of the ancients, in which vinegar was held for the use of the table.

Acini. From *acinus* a grape.

Acromion. A process of the scapula; from αxρος extremity, and ωμος the shoulder.

Anastomosis. The communication of vessels with one another; from ανα through, and ϛομα mouth.

Anatomy. The dissection of the human body; from ανα and τεμνο to dissect.

Anconeus. A muscle; so called from αγxων the elbow.

Aorta. Αορτη, from αηϱ air, τηϱεω to keep.

Aponeurosis. A tendinous expansion; from απω, and νευρον a nerve; from an erroneous supposition of the ancients, that it was formed by an expansion of nerve.

Apophysis. A process of a bone; from αποφυω to proceed from. A synonyme of process.

Arachnoides. A netlike membrane; from αραχνη a spider, and ειδος likeness.

Artery. From αηϱ air, and τηϱεω, to keep; because the ancients supposed that air only was contained in them.

Arthrodia. A species of connexion of bones; from αρθροω to articulate.

Arytænoides. The name of two cartilages of the larynx; also applied to some muscles of the larynx; from αρυταινα a funnel, and ειδος a shape.

Astragalus. A bone of the tarsus; so called from its resemblance to a die used in ancient games, from αϛραγαλος a cockal or die.

* By Dr. Hooper.

Atlas. The first vertebra of the neck; so called, because it sustains the head; from the fable of the Atlas being supposed to have supported the world; or from ατλαω to sustain, because it sustains the head.

Azygos. A term applied to parts without a fellow, from α priv. and ζυγος a yoke, because it has no fellow.

B.

Bursa. A bag; from βυρσα: generally applied to the bursæ mucosæ.

C.

Cancelli. Lattice work; generally applied to the reticular substance in bones.

Cardia. The superior opening of the stomach; from καρδια the heart.

Carotid. The name of some arteries of the neck and head, from καροω to cause to sleep; for, if tied with a ligature, the animal was said to be affected with coma.

Carpus. Καρπος; the wrist.

Clavicula. The clavicle or collar-bone, a diminutive of *clavis* a key; so called from its resemblance to an ancient key.

Clinoid. Four processes of the sella turcica of the ethmoid bone are so called, from κλινη a bed, and ειδος likeness; from their supposed resemblance to a couch.

Clitoris. A part of the female pudenda; enclosed by the labia majora; from κλειω to enclose or hide.

Colon. The first of the large intestines; from κωλον, quasi κοιλον, from κοιλος hollow.

Coracoid. From κοραξ a crow, and ειδος resemblance; shaped like the beak of a crow.

Coronary. From *corona* a crown. The vessels of the heart, stomach, &c. are so called because they surround the parts in the manner of a crown.

Cotyloid, from κοτυλη the name of an old measure, and ειδος resemblance: resembling the kotule.

Cranium. The skull; κρανιον, quasi, καρανιον from καρα the head.

Cremaster. A muscle so called; from κρεμαω to suspend, because it suspends the testicle.

Cribriform. From *cribrum* a sieve, it being perforated like a sieve.

Cricoid. Annular, round, like a ring; from κρικος a ring, and ειδος likeness.

Cuboides. A bone of the foot; from κυβος a cube, and ειδος likeness; because it resembles a cube.

Cuneiform. Some bones are so called; *cuneus* a wedge, and *forma* likeness, being shaped like a wedge.

D.

Deltoid. A muscle resembling the Greek letter Δ: from Δ, and ειδος resemblance.

Diaphragm. The muscle which separates the thorax from the abdomen; from διαφραττω to divide.
Diarthrosis. A movable connexion of bones; from διαρθροω to articulate.
Digastric. From δις twice, and γαστηρ a belly; having two bellies.
Diploe. The spongy substance between the two tables of the skull; from διπλοω to double.
Duodenum. The first portion of the small intestines; so called because the ancients supposed that it did not exceed the breadth of twelve fingers; from *duodenus*, consisting of twelve.
Dura Mater. The outermost membrane of the brain; called *dura*, because it is much harder than the other membranes, and *mater*, from the idea of the ancients that it was the source of all the other membranes.

E.

Embryo. The child in the womb is so called before the fifth month, after which, it is termed *fœtus;* from εμβροω to bud forth.
Enarthrosis. An articulation of bones; from εν, in, and αρθρον a joint or articulation.
Enteric. Belonging to the intestines; from εντερον an entrail or intestine.
Epidermis. The scarf or outermost skin; from επι upon, and δερμις the skin.
Epididymis. The small oblong body which lies above the testicles; from επι upon, and διδυμος a testicle.
Epigastric. The superior part of the abdomen; from επι upon, and γαστηρ the stomach.
Epiglottis. A cartilage of the larynx so called; from επι upon, and γλωττις the aperture of the larynx, being situated upon the glottis.
Epiphysis. A portion of bone growing upon another bone, but separated from it by a cartilage; from επι upon, and φυω to grow.
Epiploon. The membranous viscus of the abdomen, which covers the intestines, and hangs to the bottom of the stomach; from επιπλεω to swim upon.
Ethmoid. From εθμος a sieve, and ειδος resemblance; being perforated like a sieve.

F.

Fascia. An expansion, enclosing other parts, like a band; from *fascis* a bundle.
Falciform. Shaped like a sithe; from *falx*, a sithe.
Fasciculus. A little bundle, dim. of *fascis* a bundle.
Fauces. The plural of *faux*, the top of the throat.

G.

Ganglion. Γαγγλιον, a knot in the course of a nerve.

Gastrocnemius. The muscle which forms the thick of the leg; from γαςηρ a belly, and κνημν the leg.

Genio. Names compounded with this word belong to muscles which are attached to the chin, as genio-glossus, genio-hyoideus, &c.; from γενειον the chin.

Ginglymus. An articulation; from γιγγλυμος a hinge.

Glenoid cavity. From γληνη a cavity, and ειδος resemblance.

Glosso. Names compounded with this word belong to muscles which are attached to the tongue; as glosso-pharyngeus—glosso-staphilinus, &c.; from γλωσσα the tongue.

Glottis. The superior opening of the larynx at the bottom of the tongue; from γλωττα the tongue.

Glutæus. The name of a muscle; from γλϐτος the buttocks.

Gomphosis. Γομφωσις, a species of immovable connexion of bones; from γομφος a nail, because one bone is fixed in another bone like a nail in a board.

H.

Helix. The outward circle of the ear; from ειλεω to turn about.

Hepar. The liver. Ἡπαρ an abdominal viscus.

Hyaloid. From ὑαλος glass, and ειδος likeness; the capsule of the vitreous humour of the eye is so called, from its transparent and glassy appearance.

Hymen. The membrane situated at the entrance of the virgin vagina; from Ὑμην Hymen, the god of marriage.

Hyoides. A bone of the tongue, so called from its resemblance to the Greek υ; from υ, and ειδος resemblance.

Hypochondrium. That part of the body which lies under the cartilages of the spurious ribs; from ὑπο under, and χονδρος a cartilage.

Hypogastric. The lower region of the fore part of the abdomen; from ὑπο under, and γαστηρ the stomach.

I.

Ileon. A portion of the small intestines; from ειλεω to turn, being always convoluted.

Ischium. The part of the os innominatum upon which we sit; from ισχυω to sustain.

L.

Lacuna. The excretory duct of the glands of the urethra and vagina; from *lacus* a channel.

Lambdoidal suture. So called because it is shaped like the letter Λ; from Λ, and ειδος resemblance.

Larynx. The superior part of the windpipe; λαρυγξ the larynx.

M.

Masseter. A muscle of the face, which assists in the action of chewing; μασσαομαι to chew.

Mastoid. From μαστος a teat, and ειδος likeness; shaped like a nipple or teat.

Mediastinum. The production of the pleura, which divides the thorax into two cavities; from *medium* the middle, *quasi in medio stare.*

Mesentery. The membranes to which the intestines are attached: from μεσος the middle, and εντερον an intestine, because it is in the middle of the intestines.

Mesocolon. That part of the mesentery in the middle of the colon; from μεσος the middle, and κολον the colon.

Metacarpus. That part of the hand between the carpus and fingers; from μετα after, and καρπος the wrist.

Metatarsus. That part of the foot between the tarsus and toes; from μετα after, and ταρσος the tarsus.

Mylo. Names compounded with this word belong to muscles which are attached near the grinders, as *mylo-hyoideus*, &c.; from μυλη a grinder tooth.

O.

Odontoid. Tooth-like; from οδους a tooth, and ειδος resemblance.

Œsophagus. The canal leading from the pharynx to the stomach; from οιω to carry, and φαγω to eat; because it carries the food into the stomach.

Olecranon. The elbow, or head of the ulna; from ωλενη the cubit, κρανιον the head.

Omentum. An abdominal viscus; so called from *omen* a guess, because the soothsayers prophesied from the inspection of the part.

Omo. Names compounded with this word, belong to muscles which are attached to the scapula, as *omo-hyoideus*, &c. from ωμος the shoulder.

Omoplata. The scapula or shoulder blade; from ωμος the shoulder, and πλατυς broad.

Osteology. The doctrine of the bones; from οστεον a bone; and λογος a discourse.

P.

Pancreas. A viscus of the abdomen; so called from its fleshy consistence; from παν all, and κρεας flesh.

Parenchyma. The substance of some of the viscera was so called, from παρεγχυω to pour through.

Parotid Gland. From παρα near, and ους the ear; because it is situated near the ear.

Pelvis. A bony cavity shaped like a basin; from πελυς a basin.

Pericardium. The membrane which surrounds the heart; from περι around, and καρδια the heart.

Pericranium. The membrane which covers the bones of the skull; from περι around, and κρανιον the cranium or head.

Periosteum. The membrane which surrounds the bones; from περι around, and οςεον a bone.

Peristaltic motion of the intestines; from περιςελλω to contract.

Peritoneum. The membrane lining the abdomen, and covering its viscera; from περιτεινω to extend around.

Phalanx. The bones of the fingers and toes are called phalanxes, from their regular situation, like a φαλαγξ, or arrangement of soldiers.

Pharynx. A membranous bag at the end of the mouth; απο τȣ φερειν because it conveys the food into the stomach.

Phrenic or *diaphragmatic nerve.* Φρενες the diaphragm; from φρην the mind; because the ancients supposed it to be the seat of the mind.

Pia Mater. The innermost membrane of the brain, so called because it embraces the brain as a careful mother folds her child.

Pleura. The membrane lining the thorax; πλευρα the side.

Plexus. A kind of network of vessels or nerves; from *plecto*, to weave together.

Psoas. A muscle so called; from ψοα the loin, being situated in the loins.

Pterygoid process. From πτερυξ a pen or wing, and ειδος likeness, so called from its likeness to a pen or wing.

Pylorus. The lower orifice of the stomach, which opens into the intestines; from πυλοω to guard an entrance, because it guards as it were the entrance of the bowels.

R.

Raphe. A suture; from ραπτω to sew.

Renes. The kidneys, απο τȣ ρειν, because through them the urine flows.

Retina. The net-like expansion of the optic nerve, on the inner surface of the eye; from *rete* a net.

Rhomboides. A muscle so called from its shape; from ρομβος, a geometrical figure, whose sides are equal, but not right-angled, and ειδος a likeness.

Rotula. The knee-pan; a dim. of *rota* a wheel, from its shape.

S.

Sacrum. A bone so called; from *sacer* a word, because it was once offered in sacrifices.

Salvatella. A vein of the foot, so called because it was thought that opening it preserved health, and cured melancholy; from *salvo* to preserve.

Sanguis. The blood; απο τȣ σαειν γυια, because it preserves the body.

Sartorius. A muscle, so called because tailors cross their legs with it; from *sartor* a tailor.

Scapha. The depression of the outer ear, before the anti-helix; from σκαφη a little boat or skiff.
Scaphoides. A bone of the carpus, so called from its resemblance to a skiff; from σκαφη a skiff, and ειδος likeness.
Sclerotic. A term applied to the outermost or hardest membrane of the eye; from σκληροω to make hard.
Sesamoid bones. From σησαμη a grain, and ειδος likeness; from their resemblance to the semen sesami.
Sigmoid. Parts are so called from their resemblance to the letter Σ; from Σ, the letter Sigma, and ειδος likeness.
Sphenoid. From σφην a wedge, and ειδος likeness; shaped like a wedge.
Sphincter. The name of several muscles, whose office it is to shut up the aperture around which they are placed; from σφιγγω to shut up.
Splanchnic. From σπλαγχνος an entrail.
Symphysis. A connexion of bones; from συμφυω to grow together.
Synarthrosis. A connexion of bones; from συν with, and αρθρον a joint.
Synchondrosis. A species of union of bones by means of cartilage; from συν with, and χονδρος a cartilage.
Synneurosis. A species of connexion of bones by means of membrane; from συν with, and νευρος a nerve; because membranes, ligaments, and tendons, were by the ancients considered as nerves.
Syssarcosis. A species of connexion of bones by means of muscle; from συν with, and σαρξ flesh.
Systole. The contractile motion of the heart and arteries; from συστελλα to contract.

T.

Tendon. From τεινω to extend.
Thorax. Θωραξ. The breast or chest.
Thyroid. From θυρεος, a shield, and ειδος likeness; shaped like a shield.
Trachea. The wind-pipe; so called from its roughness; from τραχυς rough.
Trochanter. A process of the thigh-bone, so called from τροχος a wheel.

U.

Ulna. A name for the cubit; from ωλενη the cubit.
Ureter. The canal which conveys the urine from the kidney to the bladder; from ουρον the urine.
Urethra. The passage through which the urine passes from the bladder; from ουρον the urine.
Uvea. The posterior lamen of the iris, so called because in many

animals it is of the colour of unripe grapes; from *uva* an unripe grape.

Uvula. The conical substance which hangs down from the middle of the soft palate; so called from its resemblance to a grape. A dim. of *uva* a grape.

V.

Valves. From *valvæ*, folding doors.

Vertebræ. The bones of the spine are so called; from *verto* to turn.

X.

Xiphoid. So called from the resemblance to a sword; from ξιφος a sword, and ειδος likeness.

Z.

Zygoma. The cavity under the zygomatic process of the temporal bones; from ζυγος a yoke.

INDEX.

B

D

R

S

THE END.